THE
POPULAR SCIENCE
MONTHLY.

AUGUST, 1908

THE HISTORY OF THE CONSERVATION OF ENERGY; THE AGE OF THE EARTH AND SUN

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IN the small town of Heilbronn, in Würtemberg, stands a monument erected to the memory of the physician, Robert Mayer. It was unveiled in 1892, just fifty years after the publication of Robert Mayer's first essay on the conservation of energy. His career as a scientific discoverer is marked by many pathetic incidents. After the study of medicine he was made sanitary officer on a Dutch vessel, bent for the East Indies. During the long ocean voyage on the slow sailing vessel he was left much to himself. He gave his leisure hours to the contemplation of scientific subjects. He had occasion to observe that, in tropical countries, blood taken from the veins of patients looks almost like arterial blood. He concluded that in the tropics less oxidation is necessary than in a cold climate, in order to maintain a uniform bodily temperature. There must be a quantitative relation between the amount of heat generated and the temperature in which we live. In cold, northern climates more heat must be developed for the maintenance of uniform bodily temperature. During the 219 days between February and September, 1840, spent on the water, Mayer dwelt in close intellectual communion with nature, and she gradually revealed to him one of her most precious secrets. Upon his return to Heilbronn he kept on thinking. A moving body is brought to rest by friction; heat appears. Has the motion disappeared into nothing? Has heat sprung out of nothing? If not, then there must be an equivalence between the heat generated and the motion destroyed. *Causa æquat effectum,* "Cause is equal to effect," became his favorite axiom. At first he thought that kinetic energy varied as the velocity. Later he recognized his error and perceived its variance with the square of the velocity.

On June 16, 1841, he sent an essay embodying his new ideas for

publication in *Poggendorff's Annalen,* but the manuscript was not published nor was it returned to the author.[2] Thirty-six years later it was found among the papers of Poggendorff. In 1842 Mayer prepared a second short paper of seven pages and had the satisfaction of seeing it printed in *Liebig's Annalen der Chemie.* This was a happy time in his life, for at the very hour when he learned of the acceptance of his manuscript, he was bringing home his bride and presenting her to his aged parents.[3] But it is one thing to secure the publication of a manuscript and quite another thing to get scientific men to read and study it. A new discovery necessitates a new language. A new language is not generally understood. The curse of Babel fell upon Mayer's paper: "Confound their language, that they may not understand one another's speech." Other papers were printed by Mayer as pamphlets in 1845 and 1848.

Something of the personality of Mayer may be gained from the following stories.[4] During a hurried meeting with Mayer in Heidelberg once, Jolly remarked, with a rather dubious implication, that if Mayer's theory were correct water could be warmed by shaking. Mayer went away without a word of reply. Several weeks later . . . he rushed into the latter's presence, exclaiming, "Es ischt so!" (It is so, it is so). It was only after considerable explanation that Jolly found out what Mayer wanted to say. Of metaphysics Mayer had no appreciation. Rümelin narrates that in 1841 Mayer borrowed from him a copy of Hegel's "Logik" and Hegel's "Naturphilosophie," but returned the books a few days later with the remark that he did not understand a word, and that he could not understand any part of it, were he to study it a hundred years.[5]

For years Mayer was unable to bring his great discovery to the serious attention of scientific men. Later there followed controversies on his rights of priority. A gloom fell upon him through the death of two of his children. His mind became seriously affected, and on May 26, 1850, he unsuccessfully attempted suicide by jumping from a second-story window. In 1851 he was placed in an insane asylum, where he was cruelly treated. Two years later he was set free, but he never again regained complete mental equilibrium. Such is the pathetic story of the first discoverer of the conservation of energy.[6]

[2] "Mechanik der Wärme," von R. Mayer (ed. J. J. Weyrauch), Stuttgart, 1893, p. 16; "Kleinere Schriften u. Briefe," von Robert Mayer (ed. J. J. Weyrauch), Stuttgart, 1893, V., p. 99.

[3] "Kleinere Schriften," p. 379.

[4] Mach in the *Monist,* Vol. 6, 1896, p. 171, copied in Cajori's "History of Physics," New York, 1899, p. 210. Several passages in this address are taken from this "History of Physics."

[5] G. Rümelin, "Reden und Aufsätze," Freiburg i. B., 1881, p. 380.

[6] For a statement, by Clausius, explaining the manner in which Mayer's

In 1858 a few voices were heard in Germany in praise of Mayer, but the one who did most to bring him historical justice was John Tyndall, who in 1862 lectured before the Royal Institution on Robert Mayer.[7] I shall remain silent on the extremely bitter controversy, between Tyndall and Tait, regarding Mayer's researches.[8] Tait and William Thomson placed a low estimate on Mayer's work and brought the charge that Tyndall, by praising Mayer, was belittling the work of Joule. One would suppose that gross historical errors would have been eliminated by this time from a subject like the conservation of energy, about which so much has been written. Such is not the case. Professor R. T. Glazebrook, writing in the great "Dictionary of National Biography" (article, "Joule"), said in 1892, just before the publication of Mayer's correspondence, that Mayer in 1842 endeavored to measure the heat produced in the compression of air, but committed the very serious mistake of assuming without experimental evidence that "all the mechanical energy spent in compressing the air was used in producing change of temperature." This same criticism was passed upon Mayer by Joule, Tait and Helmholtz. A fundamental question is here involved, but the charge is not true. As early as September 12, 1841, in a letter to his friend Professor Baur, Mayer explained Gay-Lussac's experiment of 1807 on the flow of gas into a vacuum, and drew upon it to complete his argument on the equivalence of the work of compression and the heat generated by the compression. Gay-Lussac had found that when a gas expands into a vacuum it undergoes no change in temperature large enough to be detected by his thermometers. Hence, during compression practically all the work done upon the gas goes to produce change of temperature, and Mayer's argument is sound. That the criticism of Mayer's reasoning is invalid is not generally known to recent writers on the subject, but can now be verified by any one who will examine Mayer's collected works and letters, edited by Weyrauch in 1893.[9] It should be added, however, that Mayer himself is partly to blame for the strictures passed upon his paper of 1812. Gay-Lussac is not mentioned and the whole matter is disposed of in a single sentence, though that sentence, we admit, is somewhat Germanic in its structure and linear dimensions.

publications became known, consult "Die Mechanische Wärmetheorie," von R. Clausius, dritte umgearbeitete und vervollständigte Auflage, Erster Band, Braunschweig, 1887, pp. 394–403.

[7] *Proceedings of the Royal Institution*, June, 1862; *Philosophical Magazine*, Vol. 24, p. 57.

[8] See Thomson and Tait's article in the *Philosophical Magazine*, April, 1863, and various articles by them and Tyndall in Vols. 25 and 26 of the *Philosophical Magazine*, as well as translations into English of Mayer's papers.

[9] "Kleinere Schriften u. Briefe," p. 131; "Mechanik der Wärme," pp. 53, 130, 269.

Mayer's failure to secure recognition from the scientific public found its counterpart on a smaller scale with Joule and Helmholtz.

Joule was the son of a wealthy brewer. In 1830 he saw the first trains which traveled between Liverpool and Manchester. One of the happy circumstances of his boyhood life was his connection with John Dalton and Dalton's laboratory containing effective home apparatus. His association with Dalton gave direction to his constructive genius. Joule's father fixed up a room for a chemical laboratory. Before the boy was of age he began experimentation in chemistry and electricity.

After laborious tests he succeeded in showing that the heat developed by the union of two chemical elements effected in a battery is the same as that developed by combustion, and that the heat has a definite equivalent in the electromotive force between these elements.[10] He studied the relations between electrical, chemical and mechanical effects and was led to the great discovery of the mechanical equivalent of heat. In a paper read before the British Association in 1843 he gave the number as 460 kilogrammeters. This was only one year after Mayer had published his first paper. Friends who recognized the physicist in the young brewer persuaded him to become a candidate for the professorship of natural philosophy at St. Andrews, Scotland, but his slight personal deformity was an objection in the eyes of one of the electors and he did not receive the appointment.

The early papers of Joule attracted little attention. His facts were so novel, so apparently heterodox, and the language in which they were conveyed so unfamiliar, that the older physicists permitted them to remain without due consideration. Faraday was then busy with his experimental researches. Graham was studying the diffusion of gases. Wheatstone, Whewell, Herschel, Forbes, Airy were engrossed with problems of their own. Those who were first to applaud Joule a few years later were still pupils. William Thomson and Gabriel Stokes were at Cambridge; Rankine, a youth of 22, was studying engineering; Tait was a boy at school; Clerk Maxwell had just acquired the nickname of "Dafty" at Edinburgh Academy. In 1844 a paper of Joule, "On the Changes of Temperature produced by the Rarefaction and Condensation of Air," was rejected for publication by the Royal Society, but was printed in the *Philosophical Magazine* the year following.[11]

In April, 1847, Joule gave a popular lecture in Manchester, delivering the first full and clear exposition in England of the universal conservation of that principle now called energy.[12]

[10] "Memoir of James Prescott Joule," by Osborne Reynolds, 1892, p. 50.

[11] Reynolds, op. cit., p. 78.

[12] Reynolds, op. cit., pp. 104, 105.

The local press would at first have nothing to do with it. One paper refused to give even a notice of it. The *Manchester Courier,* after long debate, published the address in full. In June, 1847, the subject was presented before the British Association meeting at Oxford. The chairman suggested that the author be brief. No discussion was invited. In a moment the section would have passed on to other matters without giving the new ideas any consideration, if a young man had not risen from his seat and by his intelligent observations created a lively interest in the new theory. The young man was William Thomson, now better known as Lord Kelvin. The result was that the paper caused a great sensation. Joule had attracted the attention of scientific men. After the meeting Joule and Thomson discussed the subject further and the latter obtained ideas he had never had before.

Joule experimented on the mechanical equivalent of heat for about forty years. By magneto-electric currents he got in 1843 the value of 460 kilogrammeters as the equivalent of the large French calorie. By the friction of water in tubes he obtained 424.9; by the compression of air, in 1845, 443.8; by the friction of water he obtained, in 1845, 488.3; in 1847, 428.9; in 1850, 423; in 1878, 423.

Comparing Joule with Mayer, it will probably be admitted nowadays that Joule stands first as an experimentalist, while Mayer towers above Joule as a generalizer, as a physical philosopher.

The same year, 1847, in which Joule announced his views on energy before the British Association, Helmholtz, a youth of 26, read before the Physical Society in Berlin a paper on the same subject, entitled, "Die Erhaltung der Kraft." It was at first pronounced a fantastic speculation. The editor of *Poggendorff's Annalen,* who in 1841 declined Mayer's paper, rejected Helmholtz's also. As Joule was supported by William Thomson, so Helmholtz was defended by his fellow-student Du Bois-Reymond, and by the mathematician C. G. J. Jacobi. Helmholtz's paper was published in pamphlet form in 1847. For a time it attracted little notice, but in 1853 some parts in it were vigorously attacked by Clausius in *Poggendorff's Annalen.* Later it subjected its author to bitter attacks from Eugen Karl Dühring[13] and others, who accused him of being a dishonest borrower from his forerunner, Robert Mayer. In a publication of 1898, issued in Berlin, Dr. Thomas Gross does not quite accuse Helmholtz of plagiarism, but claims that Helmholtz did all he could to discredit Mayer. In my judgment both Dühring and Gross failed to establish their contentions. In the absence of clear evidence to the contrary we prefer to accept Helmholtz's own statement, as given in one of his lectures. Helmholtz says in one place, "The first who saw truly the general law here

[13] Dr. E. K. Dühring, "Robert Mayer, der Galilei des Neunzehnten Jahrhunderts," Chemnitz, 1880; Zweiter Theil, Leipzig, 1895.

referred to and expressed it correctly was a German physician, J. R. Mayer, of Heilbronn, in the year 1842." Then he says, "I myself, without being acquainted with Mayer or Colding, and having first made the acquaintance of Joule's experiments at the end of my investigations, followed the same path." [14]

We have now briefly sketched the birth of the principle of the conservation of energy in the minds of Mayer, Joule and Helmholtz. After examining the facts we are convinced that these great physicists were independent discoverers. Lack of time prevents us from making reference to forerunners like Count Rumford,[15] Sadi Carnot,[16] Séguin,[17] Mohr[18] and to the Dane, named Colding,[19] who in 1843 gave utterance to the law before the Academy in Copenhagen. We pass by the researches of Rankine, to whom we owe the expression, "conservation of energy," as well as William Thomson's doctrine of the "dissipation of energy."

We come now to the second part of this paper—the application of the conservation of energy and other principles of physics to the examination of the age of the sun and of the earth. The two problems are closely interrelated; the earth-age is measurable by the sun-age.

Before the time of the Scotch geologist, James Hutton, some 6,000 years was believed to indicate the age of the earth, and, indeed, of the entire universe. The advent of the uniformitarian school of geologists marks a radical departure from the old estimates. The pendulum swings from one extreme to the other. Boundless distances of time were now drawn upon. So great an antiquity of the earth seemed to reveal itself to geologists, as to defy all attempts at measurement. In the further pursuit of Hutton's line of investigation, Playfair and Lyell were unable to discover among the records of the earth and in planetary motion either a beginning or an end of the present order of things. They found no indication of infancy or decaying old age.[20]

This convenient doctrine of infinite durability came to be rudely attacked by the physicists. Here, as in the history of the conservation of energy, the earliest investigator is Robert Mayer. To be sure, he

[14] "Popular Lectures," by H. Helmholtz (transl. by E. Atkinson), New York, 1897, p. 167.

[15] "The Complete Works of Count Rumford," published by the American Academy of Arts and Sciences, Boston, Vol. I., pp. 481–488.

[16] "Réflexions sur la puissance motrice du feu," 1824, reprinted in *Ostwalds Klassiker*, No. 37; English translation by R. H. Thurston appeared in 1890.

[17] "De L'influence des Chemins de Fer," Paris, 1839, pp. 378–397.

[18] "Allgem. Theorie der Bewegung," Braunschweig, 1869, pp. 80–84.

[19] A. Colding, Det. Kongel. dansk vidensk. selsk. naturv. ogmath. afh. (5), II., 1843, p. 121, 167.

[20] Sir Archibald Geikie, presidential address before British Association, in *Report, British Association for the Advancement of Science*, 1892, Vol. 62, pp. 3–26; *Smithsonian Report*, 1892, p. 124.

did not attempt an estimate of the age of the solar system, but he discussed the preliminary question as to the source of solar heat. As soon as Mayer had convinced himself that energy can not be destroyed, and that the energy of the earth comes mainly from the sun, he began to study what Sir William Herschel had called "the great secret" of the maintenance of solar heat. In 1841, before the publication of his first paper, he asked questions relating to solar heat, in a letter to Baur, "Is it the glowing of the sun? Why does he not cool off? Is it a burning depending upon willing meteoric stones?" [21]

In 1846 he had a paper ready on this subject. Being reminded by a friend that no one can be a prophet in his own country, he sent the paper to the Academy of Sciences in Paris. A committee of the academy was directed to report on this paper, but it failed to do so and the paper was ignored. It could be published only at his own expense. It appeared in 1848 under the title, "Celestial Dynamics." Mayer concludes that the sun can not be a glowing mass, sending out radiation without compensation; solar heat can not be due entirely to chemical changes; solar heat can not be due to solar rotation. He finally embraces the theory that solar heat is due to the energy of meteors falling into the sun. He did not overlook the fact that the resulting increase of mass of the sun would increase its attraction for the planets, and would shorten the sidereal year. He knew that observation does not disclose any variation in the length of the year. An easy explanation would be offered by Newton's corpuscular theory of light, according to which the sun sends out matter into space. But this theory was then known to be untenable.* In this dilemma Mayer takes refuge in an idea which rests on a misconception of the undulatory theory of light, and he offers an explanation which is now easily recognized as invalid.

* not yet.

From Mayer we pass to William Thomson, the late Lord Kelvin, who, six years later, took up the very same problem and arrived independently at almost identically the same conclusions. That solar heat may be due to falling meteors was first suggested in England by Waterston. Unlike Mayer, Thomson sees no objection to the increase in the sun's mass resulting from meteoric showers, for, "according to the form of the gravitation theory" which he proposed, "the added matter is drawn from a space where it acts on the planets with very nearly the same forces as when incorporated in the sun." In an appendix to the paper, Thomson ventures an estimate of the age of the sun. This is the first attempt, made by a physicist, to compute the age of our great luminary and to prepare a mortuary estimate of it. He goes on the supposition that the solar energy of rotation is derived from the energy of falling meteors. He calculates that, allowing for the constant loss

[21] "Mechanik der Wärme," p. 146.

of solar energy by radiation, the sun could acquire its present energy of rotation in thirty-two thousand years. From an estimate of the limited amount of meteoric matter available near the sun, he concludes that "sunlight can not last as at present for three hundred thousand years." This calculation of the year 1854 attracted no attention at the time. Later, the theory was abandoned by its author, as at variance with known facts.

Evidently the theory of solar heat was still in a very crude form. But important new ideas were brought into view in the same year, 1854, by Helmholtz, in a popular lecture at Königsberg, delivered on the occasion of the Kant commemoration.[22] Unlike Mayer and Thomson, he starts out with the nebular hypothesis of Kant and Laplace, and derives solar heat from nebular contraction. During the contraction of the nebula from which sun and planets were formed, and also during the contraction of the sun, now assumed to be in progress, the kinetic energy obtained thereby is converted into heat and compensates for the loss of solar heat by radiation. He concludes that if the sun contracts the ten-thousandth part of its radius enough heat is generated to supply radiation for 2,100 years.[23] His figures yield twenty-two million years as the probable age of the sun, on the assumption of uniform radiation and homogeneous density. Experimental data on the intensity of solar radiation, found later by Langley, reduced this age to eighteen million or less.

Helmholtz's theory was a tremendous advance on that of falling meteors, assumed by Mayer and Thomson. No doubt meteors fall into the sun, as assumed by Mayer and Thomson, but the Mayer-Thomson theory made demands upon these meteors that bordered on extravagance. We are certain that a part of the solar heat is due to falling meteors, but its amount is as nothing, compared with the heat resulting from the gravitational energy of shrinkage. Until recently these were the only important sources considered.

In the sixties fresh attacks were made on the problem of the age of the sun by William Thomson. In 1862 appeared in the *Macmillan's Magazine* an article, "On the Age of the Sun's Heat,"[24] in which he favors a (nebular) meteoric theory like that of Helmholtz, by which there is no difficulty in accounting for 20,000,000 years' heat radiated by the sun. He concludes that we may accept "as a lowest estimate for the sun's initial heat, 10,000,000 times a year's supply at present rate, but 50,000,000 or 100,000,000 as possible, in consequence of the sun's greater

[22] H. Helmholtz, "Popular Lectures" (transl. by E. Atkinson), New York, 1897, pp. 153–193, "On the Interaction of Natural Forces."

[23] Op. cit., p. 190.

[24] Sir William Thomson's "Popular Lectures and Addresses," Vol. I., 1891, pp. 356–375.

density in his central parts."[25] "As for the future, . . . inhabitants of the earth can not continue to enjoy the light and heat essential to their life, for many million years longer, *unless sources now unknown to us are prepared in the great store-house of creation.*" More detailed studies of the same subject were made in 1887, in a lecture "On the Sun's Heat," delivered before the Royal Institution of Great Britain.[26]

In this lecture Sir William Thomson refers to a very able paper, "On the Theoretical Temperature of the Sun," by J. Homer Lane,[27] of Washington, which establishes the apparently paradoxical statement that, within certain limitations, the more heat a gaseous body loses by radiation, the hotter it will become. This theorem was discussed in connection with the solar heat by Benjamin Peirce,[28] Simon Newcomb[29] and Sir Robert Ball.[30] Results similar to Lane's were reached in the years 1878–83 in a series of very exhaustive papers by A. Ritter.[31] A rival to the Helmholtz-Thomson theory of solar heat was advanced about 1882 by William Siemens,[32] who imagined the rotating sun to hurl, by centrifugal action at his equator, enormous quantities of gas into space, which returned to him again at the poles.

A refinement of the theory as presented by Helmholtz was introduced in 1899 by T. J. J. See,[33] wherein he abandoned the Helmholtzian hypothesis of a sun of homogeneous density and, using Lane's law, investigated minutely the more complex case of central condensation. Thereby the probable solar age was extended from about 18 to about 32 million years.

Returning to the problem of the age of the earth, considered independently of the sun, we find William Thomson the great moving spirit. He approached the subject from more than one point of view. One argument for limitation of the earth's age was based on the consideration of underground heat.[34] "The heat which we know by

[25] Op. cit., p. 375.

[26] Op. cit., pp. 376–429.

[27] *American Journal of Science*, 2d S., Vol. 50, 1870, pp. 57–74.

[28] *Proceed. Am. Acad.*, XV., p. 201.

[29] "Popular Astronomy," 1st ed., p. 508; "The Stars," New York, 1901, p. 210.

[30] "Story of the Heavens," London, 1893, p. 497.

[31] *Wiedemann's Annalen*, V., p. 405; X., p. 13; XI., p. 978; XII., p. 445; XIII., p. 360; XIV., p. 16; XVI., p. 166; XVII., p. 322; XVIII., p. 488; XX., pp. 137, 897. See Rosenberger, "Geschichte der Physik," Vol. III., 1887, pp. 689, 690.

[32] "Ueber die Erhaltung der Sonnenenergie," Uebersetzt von C. E. Worms, Berlin, 1885; see Rosenberger, "Geschichte der Physik," Vol. III., p. 687.

[33] *Science*, N. S., Vol. IX., 1899, pp. 737–740.

[34] W. Thomson, "The Doctrine of Uniformity in Geology Briefly Refuted," read in 1865 before the Royal Society of Edinburgh. See *Smithsonian Report*, 1897, p. 343.

observation to be now conducted out of the earth yearly is so great that if this action had been going on with any apparent uniformity, the history of life on the earth could not exceed a few thousand million years." Another consideration leading to similar conclusions was based on the shape and rigidity of the earth. With Sir William Thomson, the age of the earth continued to be a question studied with great predilection. His aim was not so much to determine the exact age as to fix an upper age limit. As the years passed by, investigation supplied much of the knowledge which was at first wanting regarding the thermal properties of rocks, and Sir William Thomson was able greatly to reduce this upper limit.

"The Physical Condition of the Earth" was the topic of Sir William Thomson's presidential address in 1876, before Section A of the British Association. He took the gradual increase of temperature downwards to be on an average 1° C. for 30 meters of descent and gave reasons for his belief that for great depths the rate of increase does not diminish. He concludes that if at great depths the temperature does not exceed 4,000° C., then the geological age of the earth does not exceed 90 million years. This argument involves some very uncertain factors. Sir William Thomson has shown quite conclusively that the earth's interior is solid, but at what temperature the substance of the earth would begin to melt under the high internal pressures was a matter of pure conjecture.

About 1885 Carl Barus, of the United States Geological Survey, made a series of very important experimental researches on the physical properties of rocks at high temperatures, for the purpose of supplying trustworthy data for geological theory.[35] Mr. Clarence King, in an article published in the *American Journal of Science*,[36] used the data on specific heats, thermal conductivities and temperatures of fusion of rocks, which had been supplied by Barus, for a more accurate determination of the age of the earth. King concludes from these experimental data on diabase, "that we have no warrant for extending the earth's age beyond 24,000,000 years." A computation made by Lord Kelvin led to about the same figure.[37] These results were embodied by him in his address of 1897 before the Victoria Institute.

What was the attitude of geologists toward these researches? In England, geologists did not pretend to be able to find any flaw in the argument of Lord Kelvin, but they were in a position described in the well-known couplet,

> "A man convinced against his will
> Is of the same opinion still."

[35] *Am. Jour. of Science*, 3d S., Vol. 42, p. 498; Vol. 43, p. 56.

[36] "On the Age of the Earth," 3d S., Vol. 45, 1893, pp. 1–20. See also *Smithsonian Report*, 1897, p. 345.

[37] *Smithsonian Report*, 1897, p. 346.

To the geologist, yonder snow-capped peaks symbolized eternity; to the physicist, the mountains were as transient as the clouds.

A calm statement of the geologists' attitude was made before the British Association in 1892 by Sir Archibald Geikie.[38] In one place he expresses himself as follows:

> Lord Kelvin is willing, I believe, to grant us some twenty millions of years, but Professor Tait would have us content with less than ten millions. . . . I frankly confess that the demands of the early geologists for an unlimited series of ages were extravagant . . . and that the physicist did good service in reducing them. . . . That there must be some flaw in the physical argument I can, for my own part, hardly doubt, though I do not pretend to be able to say where it is to be found. Some assumption, it seems to me, has been made, or some consideration has been left out of sight, which will eventually be seen to vitiate the conclusions, and which when duly taken into account will allow time enough for any reasonable interpretation of the geological record.

Five years later an American geologist, Professor T. C. Chamberlin, invaded the domain of physics and made a vigorous attack on Lord Kelvin's argument, challenging the correctness of some of his assumptions.[39] This criticism did not secure the attention it deserved, for scientific events soon took a different turn.

Lord Kelvin's address of 1897 is permeated, as Professor Chamberlin puts it, "with an air of retrospective triumph and a tone of prophetic assurance." "It is only by sheer force of reason," says Kelvin, "that geologists have been compelled to think otherwise, and to see that there was a definite beginning and to look forward to a definite end of this world as an abode fitted for life." Nor was this feeling of retrospective triumph confined to Lord Kelvin or to the students of the problem of the age of the sun and earth. At the close of the century physicists and chemists gloried in the triumphs of their predecessors, in such achievements as are indicated by the words "conservation of energy," "conservation of mass," and "atomic theory." In physical research the nineteenth century was a golden age. It produced Faraday, Helmholtz, Mayer, Joule, Kelvin, Rayleigh, Rowland and many other great men. With the close of the century timid souls doubtless feared that the golden age had come to a close, and they perhaps experienced strange emotions like those attributed to Adam in the Garden of Eden, on seeing the sun go down, not knowing that it would ever rise again.

Others were perhaps haunted by another fear—a feeling that the great and fundamental truths of science were all revealed to the full sight of man, and it now remained only to work out the less important

[38] *Smithsonian Report*, 1892, p. 125.

[39] *Science*, N. S., Vol. IX., pp. 889–901; Vol. X., pp. 11–18, 1899. Reprinted in *Smithsonian Report*, 1899, pp. 223–246.

details. Some doubtless felt disheartened because of lack of opportunity, as did the Edinburgh anatomist, Dr. John Barclay a century ago. Dr. Barclay looked upon the great anatomists of earlier periods as "reapers who, entering upon untrodden ground, cut down great store of corn from all sides of them. . . . Then come the gleaners who gather up ears enough from the bare ridges to make a few loaves of bread. Last of all come the geese, who still continue to pick up a few grains scattered here and there among the stubble, and waddle home in the evening, poor things, cackling with joy because of their success." But the history of science shows that Dr. Barclay's reapers, gleaners and geese do not belong to separate epochs. They are contemporaneous. The reaping, gleaning and cackling go on as a rule in the same field, all at one time, in a grand comic medley of sounds. It is certain that anatomists had not so nearly exhausted their field one hundred years ago as Dr. Barclay believed that they had.

We are told that, about 1878, the president of a certain chemical society informed his hearers in an annual address that the age of discovery in chemistry was closed, and that henceforth we had better devote ourselves to a thorough classification of chemical phenomena. But at that very time Crookes was experimenting in England on high vacua, and the year following he electrified the British Association by his brilliant experiments on "radiant matter." Then came the Lenard rays and in 1895 the Roentgen rays, in 1896 the Becquerel rays and in 1899 radium, with its mysterious radiation. This was followed by the report that probably all matter is slightly radio-active. The study of these phenomena has shaken the old atomic theory, and calls for a reexamination of the principle of the conservation of energy and of matter. The earthquake in San Francisco did not shake buildings so violently as did these new facts shake the great edifice of physical science. The principle of the constancy of matter was called in question in an experiment of Kaufmann on particles shot off from radium.[40] This experiment is hard to interpret, but I am not aware that J. J. Thomson, or Rutherford, or Soddy, or Boltwood, is denying the indestructibility of matter. One French experimentalist, however, LeBon,[41] has advanced the new theory of the destructibility of matter to explain the new phenomena. He advances his new theory as a demonstrated fact, and assumes to speak *ex cathedra,* when others observe extreme caution. Were he advancing the destructibility of matter merely as a working hypothesis, few could complain; but he puts it forward as a firmly rooted fact.

[40] See J. J. Thomson, "Conduction of Electricity through Gases," 1903, p. 534.

[41] Dr. Gustave Le Bon, "The Evolution of Matter" (translated by F. Legge), 1907, Charles Scribner's Sons.

The principle of the conservation of energy has quite withstood all attacks. To be sure, Le Bon claims to have overthrown it, too,[42] but the validity of his argument is questionable. Even scientists sometimes play with logic. You have heard the story of the Assyriologist who argued: "The Assyrians understood electric telegraphy, because we have found wire in Assyria." "Oh," replied the Egyptologist, "we have not found a scrap of wire in Egypt, so we know the Egyptians understood wireless telegraphy."

In the presidential address before the British Association in 1907, Professor E. R. Lankester uttered the following weighty words: "The kind of conceptions to which these and like discoveries have led the modern physicist in regard to the character of that supposed unbreakable body—the chemical atom—the simple and unaffected friend of our youth—are truly astounding. But I would have you notice that they are not destructive of our previous conceptions, but rather elaborations and developments of the simpler views, introducing the notion of structure and mechanism, agitated and whirling with tremendous force, into what we formerly conceived of as homogeneous or simply built-up particles, the earlier conception being not so much a positive assertion of simplicity as a non-committal expectant formula awaiting the progress of knowledge and the revelations which are now in our hands."[43]

This same address touches questions of cosmical physics. It says:

> Radium has been proved to give out enough heat to melt rather more than its own weight of ice every hour; enough heat in one hour to raise its own weight of water from the freezing point to the boiling-point. . . . Even a small quantity of radium diffused through the earth will suffice to keep up its temperature against all loss by radiation! If the sun consists of a fraction of one per cent. of radium, this will account for and make good the heat that is annually lost by it.

He continues to say:

> This is a tremendous fact, upsetting the calculations of physicists as to the duration in past and future of the sun's heat and the temperature of the earth's surface. The physicists, notably Professor Tait and Lord Kelvin, . . . have assumed that its material is self-cooling. . . . It has now, within these last five years, become evident that the earth's material is *not* self-cooling, but on the contrary self-heating. And away go the restrictions imposed by physicists on geological time. They now are willing to give us not merely a thousand million years, but as many more as we may want.

Some of the views relating to radium, expressed in the summer of 1906 at the York meeting of the British Association, appeared to Lord Kelvin open to objection. It seemed to him that some of the younger

[42] Le Bon, op. cit., pp. 17, 18, 53, 54.

[43] E. Ray Lankester, inaugural address before British Association, *Nature*, Vol. 74, 1906, p. 325.

men were carried away by the strangeness of the new phenomena and were ready to adopt the most extravagant theories when there was no logical necessity for abandoning old views and, in their intoxication, were embracing new hypotheses without exercising due circumspection. After the meeting Lord Kelvin boldly opened a controversy in the London *Times*. Almost single-handed the old warrior fought with great intellectual keenness against the transmutational and evolutionary doctrines, relating to the chemical elements, framed by the younger investigators, to account for the properties of radium.[44] Among his opponents were Sir Oliver Lodge, the Hon. Mr. Strutt, Mr. A. S. Eve and Mr. F. Soddy. It can not be said that Kelvin was victorious, but the controversy helped to define the points at issue. Among other things, Lord Kelvin said that there was no experimental foundation for the assertion that the heat of the sun was probably due to radium. He was still inclined to ascribe it to gravitation. Lord Kelvin also denied that it was proved that the heat of the earth is due to radium. It was possible, he claimed, that radium does not decompose under the conditions prevailing in the interior of the earth, and in that case it emits no heat.

In considering the perturbations produced by radium in the progress of our ideas, it is well to remember that, thus far, we have been able to experiment with radium in only small amounts. Professor Lankester remarks that the Curies never had enough of radium chloride to venture on any attempt to prepare pure metallic radium.

> Altogether the Curies did not have more than some four or five grains of chloride of radium to experiment with, and the total amount prepared and now (1906) in the hands of scientific men in various parts of the world probably does not amount to more than 60 grains at most. When Professor Curie lectured on radium four years ago at the Royal Institution in London he made use of a small tube an inch long and of one-eighth inch bore, containing nearly the whole of his precious store, wrenched by such determined labour and consummate skill from tons of black shapeless pitch-blende. On his return to Paris he was one day demonstrating in his lecture room with this precious tube the properties of radium when it slipped from his hands, broke, and scattered far and wide the most precious and magical powder ever dreamed of by alchemist or artist of romance. Every scrap of dust was immediately and carefully collected, dissolved, and re-crystallised, and the disaster averted with a loss of but one minute fraction of the invaluable product.[45]

In a reinvestigation of the age of the earth it is extremely important to undertake extensive investigation of the amount of radium contained in the various rocks. Such researches have been begun by the Hon. R. J. Strutt. He has made determination of the amount of radium in rocks at the surface of the earth, and has found about

[44] See *Nature*, Vol. 74, 1906, pp. 516–518.

[45] *Nature*, Vol. 74, 1906, p. 323.

3×10^{-12} grains of radium as the average amount present in 1 c.c. of soil.

From the rate of increase of temperature below the earth's surface and the heat conductibility of rocks, Mr. Strutt concludes that radium is confined to a comparatively thin crust of the earth. While these reasons are not conclusive, they are weighty. Our incomplete knowledge of the properties and the distribution of radium and other radio-active substances, makes it necessary to suspend judgment on the age of the earth. There is no necessity that the question be settled immediately.

The same remark applies to the antiquity of the sun. Much depends upon the presence or absence of radium there. As yet this substance has not been found in the sun, but the presence of helium, combined with the fact that helium may be obtained from radium, renders the presence of radium in the sun quite probable. That radium affects the problem of the solar age was pointed out by Mr. G. H. Darwin in the following words:[46]

> Knowing, as we now do, that an atom of matter is capable of containing an enormous store of energy in itself, I think we have no right to assume that the sun is incapable of liberating atomic energy to a degree at least comparable with that which it would do if made of radium. Accordingly, I see no reason for doubting the possibility of augmenting the estimate of solar heat as derived from the theory of gravitation by some such factor as ten or twenty.

In conclusion, it is very evident that, however unpleasant it may be for the older men to revise their theories to meet the demands of new observations, we have in radio-activity the entrance into a region of new knowledge which will cast light upon many a dingy avenue of philosophy. Great are the trials and great the final triumphs of experimental science.

In Norse mythology there is a wonderful tree called Igdrasil, whose branches spread over the whole earth and reach up into the clouds. At the foot of the tree, away down at the deepest root, is a well from which the tree draws its sap. To us of the twentieth century that tree symbolizes science. The well which nourishes the tree is the fountain of eternal truth.

[46] *Nature*, Vol. 68, 1903, p. 496.

FLORISSANT; A MIOCENE POMPEII

By Professor T. D. A. COCKERELL

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IN attempting to trace the evolution of plants and animals, the naturalist finds himself continually regretting what is called "the imperfection of the geological record." Of all the creatures which have lived and died upon the earth, only a very small proportion have left any record in the rocks; and since the remains are widely scattered and belong to very diverse periods of time, anything like a complete consecutive series is usually unattainable. It is somewhat as though the student of languages of some future age might be obliged to depend for his knowledge of the English tongue upon small fragments of the pages of Webster's Dictionary, perhaps about an inch square for each page. He would gather his precious scraps together, and by diligently comparing them, would readily deduce a number of things about the construction of the language. He would feel able to restore, in some measure, a certain proportion of the missing words, forming derivatives according to the rules he had been able to ascertain. But how he would long for a single complete page!—for a single series actually presenting to him the different modifications and amplifications of some root in all their richness and variety.

Each year witnesses an increasing number of paleontological discoveries, so that the incomplete series in our museums are gradually becoming more complete and more representative of the actual course of evolution. In some well-known instances, such as those of the horse and elephant groups, the successive stages are now so well known that it is not very difficult for imagination to supply the connecting links; but in others the record is either a total blank or a miserable scrap merely sufficient to awaken curiosity. Take, for instance, the butterflies. According to Dr. D. Sharp, the living species of butterflies known to science number about 13,000, while it is not impossible that 30,000 or even 40,000 actually exist. Butterflies form such a large and varied group, spread over nearly every part of the world where vegetation grows, that it is certain that they have a long history behind them, and that the total number of forms which have existed must run into the hundreds of thousands. Yet the actual number of fossil butterflies so far discovered is only twenty-two! Even this meager figure is in a sense an exaggeration, inasmuch as many—indeed most—of the

FOSSIL CALYX OF *Porana tenuis*. ⅔ (The genus is now Asiatic.)

species are only partially known from very incomplete fragments. The paleontologist and the historian not only desire to know how successive events are related, but are keenly alive to the necessity for detailed information concerning the contemporaneous events and objects of any one period. Hence it is that the uncovering of Pompeii and Herculaneum stirs the blood of the most lethargic, for there is presented to our gaze the actual life of nearly two thousand years ago in all its detail and variety. We know, perhaps, that the ancients had certain customs, used certain tools, enjoyed particular kinds of art and literature; but to accurately restore their daily life, even with the aid of many brilliant descriptive passages left by their writers, was a difficult feat for the imagination. To find two cities buried just as they stood at the beginning of the Christian era is not merely to gain an incalculably precious insight into the life of that period, but to obtain a landmark of the utmost service for comparisons, both with earlier and later times.

For like reasons, the naturalist may well look for earlier deposits in which living animals and plants are preserved somewhat as at Pompeii; and may feel thankful if in all the world one or two such places exist.

The most famous of such localities is Œningen, on the north or Baden side of a narrow arm of Lake Constance leading to the Rhine. The products of this wonderful fossil-bed—or rather, succes-

FOSSIL LAND SNAIL (*Vitrea fagilis*). (Enlarged.)

sion of fossil-beds—have been principally elucidated by Heer, who was professor at the University of Zurich, and for many years the leading authority on fossil plants and insects. There were found more than 450 different kinds of plants, over 470 species of insects, and many fishes, reptiles and other animals. In America the corresponding locality, much more recently discovered, and much less extensively worked, is Florissant, in Colorado.

The first notice of Florissant as a locality for fossils was given by Mr. A. C. Peale in the "Annual Report of the U. S. Geological Survey of the Territories," in 1874. It was remarked that in the upper part of the valley on the South Platte River, a few miles from Pikes Peak, there was an ancient lake basin, marked by extensive deposits in which were found remains of leaves. In the years following, the place was visited by various naturalists, several of whom made collections. In 1877, Dr. S. H. Scudder, accompanied by Messrs. Arthur Lakes, of Golden, Colorado, and F. C. Bowditch, of Boston, spent the summer there, and made an enormous collection, especially of fossil insects. Mrs. Charlotte Hill, a resident of Florissant, also became interested, and with the aid of the neighboring children gathered together many valuable specimens, which are now to be found in various museums. An expedition from Princeton University, including the well-known paleontologists, W. B. Scott and H. F. Osborn, also went to Florissant, and the collections obtained were in part sent to the British Museum, and probably to other institutions. Another large collection was made by Dr. G. Hambach, of St. Louis, Mo., forming the basis of a paper on the fossil flora by Mr. W. C. G. Kirchner.

After a period of activity lasting a number of years, interest in Florissant died down, and not only were the fossil beds neglected, but hundreds of precious specimens already gathered were allowed to remain hidden away in various museums and colleges unstudied. When the material first came in, all the fossil plants were referred to Leo Lesquereux, who was at that time the one great authority on paleobotany in this country. Lesquereux published many descriptions of Florissant plants in his great works on the "Tertiary Flora" and "Cretaceous and Tertiary Floras," issued in sumptuous form by the U. S. Geological Survey in 1878 and 1883, respectively; while Dr. Scudder took charge of the insects, and wrote several very important monographs, the largest being that on "Tertiary Insects," published by the Geological Survey in 1890. When Lesquereux died, and later Dr. Scudder was incapacitated by paralysis from doing any further work, it was natural that Florissant should be neglected, for these two men were almost the sole authorities upon the subject. Furthermore, although the Geological Survey had in former years used funds for the Florissant work, and in particular had published the results at great

expense, the fact that the latter were of no obvious value to the mining or kindred interests led to a withdrawal of financial support. That the restoration of the past—the discovery of the conditions which obtained in Colorado perhaps a million years ago—is of no value to mankind is a proposition which would scarcely be endorsed by any scientific man; but the fact remains that our present-day public makes a stronger demand for cash than for philosophic illumination, and the latter must often wait.

In the summer of 1905 the Florissant work was taken up anew by the University of Colorado, and Judge J. Henderson and Dr. F. Ramaley, of that institution, went there and collected a quantity of material. In 1906 a new expedition, consisting of Dr. W. M. Wheeler, of the American Museum of Natural History, and Mr. and Mrs. Cockerell and Mr. S. A. Rohwer, of Boulder, Colorado, spent a considerable time excavating fossils; and in 1907 the work was carried on still more extensively, with the financial cooperation of the American Museum of Natural History, Yale University, the British Museum and the University of Colorado. As a result, there has accumulated an almost embarrassing amount of material, and many remarkable things have been discovered.

Florissant is to-day a small town on the Midland Railroad of Colorado, about as far west of Pikes Peak as Colorado Springs is east of it. It is situated in an open valley or "park," surrounded by low hills, and consisting mainly of rather barren grass-land, with moister and even swamp areas along the creeks. The altitude is about 8,000 feet, and is far above the zone of oak bushes which forms such a conspicuous feature in the vicinity of Manitou. The hills are clothed with an open forest of conifers, mostly pines, and owing to the dry and sunny character of the locality, some of the southern plants, such as the Spanish Bayonet or Yucca, grow in abundance, The town itself is small, and exists principally for purposes connected with the railroad; it is a shipping point for a certain amount of lumber, but in no sense a mining center.

In ancient times—say about a million years ago—the valley was the site of a beautiful lake—Lake Florissant. This body of water was perhaps about nine miles long, but very narrow, and strongly indented by wooded headlands at every point. Here and there were small islands, upon which grew tall redwood trees and other vegetation. It was just such a place as would have delighted the heart of Fenimore Cooper and his hero of the Leatherstocking tales. The climate was very different from that of modern Colorado; mild, warm and damp, not unlike that of the uplands of our southern states. Yet the hills were probably rather dry, for we find remains of plants suited to diverse ecological conditions, from semi-arid uplands to swamps. Not far away

vapor and fumes arose from several volcanic vents, and at frequent intervals there were showers of fine ash, while more rarely molten lava escaped and flowed down the slopes into the lake. During the larger eruptions, as has been recently witnessed at Martinique, there were violent gusts of wind, and blazing cinders of various sizes fell on all sides. Green branches were torn from the trees, and are found with the leaves still attached in the shales; while many leaves are burned and torn, and an abundance of charcoal testifies to the existence of forest fires. The clouds of fine ash bore to the ground all winged insects and, when falling in the shallow water of the lake, gave rise to layers of soft mud and sand, which, under the pressure of subsequent deposits, solidified into rock. In this way the shales were formed, the best being under heavy flows of mud or lava, which compressed them and permitted the preservation of the remains they contained, before decomposition had gone too far. Within a limited area hot waters strongly charged with silica surrounded and bathed the remains of the redwood trees, with the result that these are now wonderfully preserved as fossil stumps, one of them of great size.

In the course of ages, after the lake had disappeared, the streams flowing through the valley cut out the soft shales and carried them in fine particles to the Platte River, whence they found their way toward the plains. It is sad to think of the thousands of magnificent fossils which must have been thus destroyed—the infinitesimal fragments of which are now scattered far and wide over the Colorado plains, or have traveled perhaps to the Mississippi and the sea. The result of all this destruction, however, has been favorable to the paleontologist in this sense, that it makes the shales readily accessible at many points. Along the sides of the valley, close to the old shore lines, the fossil-bearing layers are plainly visible, and no doubt those which are preserved are far richer than were those which occupied the middle of the lake. The amount of the deposit still remaining is not known, but it must be very great, so that its possibilities could not be more easily exhausted than those of Herculaneum. Only a few places have been worked for any length of time, while small outcrops, inviting investigation, are very numerous. The work of uncovering the fossils is necessarily very slow. First of all, the heavy cap of solid rock has to be removed—and the farther one goes into the hillside, the greater it is—and then the shale has to be split with a knife into fine layers, often with great difficulty. With the utmost care, it is certain that many things will be lost, either from not being observed when uncovered, or from the shale not splitting in the right places. It would not be practicable to have the work done by untrained laborers, with the exception of the preliminary digging and shoveling, for they would destroy and lose far more than they found. Frequently the most precious and perfect insect remains are

FOSSIL TSETSE FLY (*Glossina oligocœna*). The tsetse flies are no longer found in America. (Much enlarged.)

scarcely visible at all, especially on the wet shale as it is dug out; but under a strong lens they show every detail of the structure of the wings. On the other hand, some specimens which superficially appear excellent prove upon minute examination to be of small scientific value.

When the fossils have been obtained, it is no easy matter to determine and describe them. In the case of the plants, many species are easily recognized and can be classified with much certainty; but there are living species of oaks and maples, for example, which possess foliage wholly unlike that which we usually associate with those names. A maple from Japan, judged by its leaves, would be taken for a hornbeam; some oaks resemble willows. The commonest leaf in the shales was considered by Lesquereux to be allied to the water elm of the southern states; but we have found some pieces with the fruit attached, and it seems to be a beech. Calyces, once supposed to belong to persimmon or some allied plants, prove to be those of a poplar; while the giant redwood itself was first introduced as a moss, from a fragment of a twig!

The insects, when well preserved, offer much better characters than most of the plants. Unfortunately, however, they are frequently indistinct or fragmentary, and the accurate determination of the remains becomes extremely difficult. Only those who have worked on fossil insects can appreciate at their proper value the tremendous labors of Scudder, resulting in the description and classification of many hun-

dreds of species. Sometimes very striking structural characters may be observed; but when assistance is sought from the literature on living forms, the student finds that characters of this class have been ignored, and it is necessary to make a fresh study of the modern genera before proceeding with the fossils. In order to do this, however, large collections are needed, and it is no easy matter to secure sufficient specimens. Thus, in one way and another, the opportunities for error in the study of fossil insects and plants are very many; so many, that it is easy to become discouraged, and yield to the temptation to confine oneself to the comparatively easy problems presented by modern types. In such times of discouragement, however, the student may be cheered by the discovery of some splendid thing, telling a tale beyond dispute; and so he returns to his labors, determined to unravel the secrets of the past, and to accept as philosophically as may be the inevitable results of his inability to avoid a certain percentage of error.

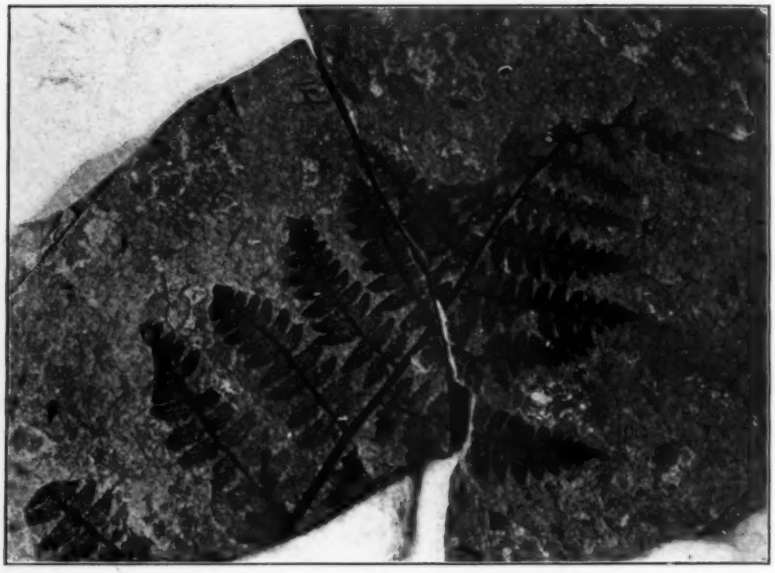
In an effort to reconstruct the landscape of the Miocene period in Colorado, we may well begin with the plants. The number of fossil plants described from Florissant is not nearly so great as that from Œningen; but the deposits of the latter locality are, apparently, not so nearly contemporaneous; while, on the other hand, not nearly all the Florissant species that have been found have yet been published. The collections of the 1907 expedition, rich in new materials, have only

FOSSIL WHITE ANT (*Hodotermes coloradensis* of Scudder).

recently been unpacked, and their study has scarcely more than begun.

The shores of the lake, while doubtless steep in places, must have sloped gradually at many points, and there was much shallow water. In this grew the broad-leafed cat-tail of those days, the *Typha lesquereuxi.* The remains of its leaves are found in the greatest abundance and upon some of them it has even been possible to detect a fungus, which has been called *Didymosphæria betheli.* In the water near the bases of the cat-tails was a duckweed. Water lilies have not been found; a round water-lily-like leaf proves to belong to a semi-aquatic plant, a kind of frog's-bit. A small rush, a species of *Juncus,* scattered its fruits everywhere. Small fresh-water molluscs, similar to those of the present day, abounded. There were bivalved forms (*Sphærium*), and representatives of the pond snails *Lymnæa* and *Planorbis.* Dragon-fly and May-fly nymphs were excessively numerous, especially the latter; while the adult insects flew along the shore. Minute bivalved crustacea were in myriads, but no crayfishes have been detected, and there is no reason for supposing that any existed. In slightly deeper water, there were innumerable fishes, and well-preserved specimens of several species have been obtained. From the fish specimens actually secured, one might suppose that these animals were comparatively rare; but this idea is contradicted by the abundance of their excrement, often containing ants and other insects which may have been killed by the volcanic fumes or ash. It would seem, indeed, that at the beginning of an eruption, the fishes gorged themselves with the falling insects; but when things got too hot for them, they mostly retreated in safety to deeper waters, where they escaped entombment. No frogs or turtles have been obtained, much to our disappointment; it is hardly to be supposed that there were none—we may rather anticipate that they will be unearthed by some happy collector of the future. Near the shores, the principal trees were the narrow-leafed cottonwood —differing little from the one common in Colorado to-day—a kind of beech, *Fagus longifolia,* and a *Myrica* with slender twigs, which may not have been more than a shrub. A little more distant from the water, perhaps, were the redwoods, *Sequoia haydeni,* very like those growing in California at the present time. Under or near the redwood grew the incense cedar, a tree now confined to the Pacific coast (where it still grows with *Sequoia*) and China, though a closely allied genus occurs in the southern hemisphere. There were no firs or spruces, but two or three species of pine trees were plentiful, probably upon the tops of the little hills; and a shrubby or tree-like juniper—like the so-called cedar of modern Colorado—was a conspicuous object. The warmth and dampness of the climate are indicated by an abundance of ferns, such as may be seen in the forests along the Hudson at the present time. Indeed, the whole aspect of the country must have been

much more like that of the forest region of the eastern states than any part of Colorado to-day. After working at Florissant in the summer of 1907, I had occasion to spend some time at Garrison-on-Hudson, and as I daily went through the splendid woods of that region, it seemed to me as if the flora of the shale had come to life. There was the sweet fern, *Comptonia,* to-day confined to a single species of the eastern United States; in Miocene times wide-spread, and represented by two kinds at Florissant. There was the large-toothed aspen; leaves with even larger teeth, but very similar, were found in the shales. Then the chestnut—great chestnut leaves, of an undescribed species, were among the best of our finds. So also the basswood, the walnut, the ironwood, elm, hickory, holly and many other trees, now wholly



FOSSIL FERN (*Phegopteris guyottii*).

absent from Colorado, but common to the Miocene shales and the eastern states. One of the most interesting of the fossils is the sweet-gum, or *Liquidambar;* a genus widely dispersed in the Miocene, from America to Europe, while now its few scattered remnants are found in our Atlantic coast region, in Mexico and Central America and in Asia. On the other hand, the existing Rocky Mountain flora is represented in the Florissant shales by species of oak, alder, birch, hackberry, barberry, mock-orange or Philadelphus, maple, gooseberry, grape, rose, hawthorn, mountain ash, willow, Virginia creeper, sumach and a number of others, showing that with all the change of climate which has occurred, the flora has not been totally transformed.

No recognizable mammal has been obtained at Florissant; only a

FOSSIL SOAPBERRY TREE (*Sapindus stellariæfolius*).

few fragmentary remains, without a skull. There is no doubt that mammals of many kinds abounded in the vicinity of the lake, and it is very likely that some of them were entombed, their bones waiting to be exhumed by some fortunate paleontologist of the future.

Feathers are occasionally found, and two fairly complete birds have been discovered, one a plover, the other apparently a finch. The fishes already mentioned number eight species. Of molluscs, we know two terrestrial species and four or five fresh-water ones. Thirty different spiders have been described by Scudder, and we have found others. The harvest spiders or phalangids, and the millipedes, are each represented by a single kind. It is for the insects, of course, that Florissant is most famous, surpassing even Œningen.

Mr. Scudder wrote:

> The insects preserved in the Florissant basin are wonderfully numerous, this one locality having yielded in a single summer more than double the number of specimens which the famous localities at Œningen furnished Heer

in thirty years. Having visited both places, I can testify to the greater prolificness of the Florissant beds. As a rule the Œningen specimens are better preserved, but in the same amount of shale we still find at Florissant a much larger number of satisfactory specimens than at Œningen, and the quarries are fifty times as extensive and far more easily worked.

The total number of species of insects so far described from Florissant is about seven hundred, but several hundreds have been found, belonging to groups not yet worked up. The list, as it stands, contains only a single ant, but, as a matter of fact, ants are much more abundant than any other insects, at least in individuals. Those obtained by Scudder, and also the materials secured by the recent expeditions, are all in the hands of Dr. W. M. Wheeler, of the American Museum of Natural History. His account of them will be of extraordinary interest, based as it will be on the examination of thousands of specimens by a naturalist fully competent to make them contribute, not

FOSSIL INCENSE CEDAR (*Heyderia coloradensis*) with small piece of redwood (*Sequoia haydeni*). (Enlarged.)

merely to the science of myrmecology, but to wider biological theories as well. It is, indeed, through the examination of myriads of specimens representing particular periods in the history of the world, that we may expect to solve some of the most difficult questions of evolution. Scudder noticed that among certain of the groups of fossil insects there were particular tendencies observable throughout, notwithstanding the fact that the species belonged to different groups. Legs had grown longer, or wing-cells had shortened, since the Miocene, and different series, already at that time quite separate and free from crossing, had been affected in the same manner. The same sort of thing was later remarked by Professor Osborn in the teeth of extinct animals, and he became convinced that there were fundamental predispositions to vary in particular directions. Theories of this sort, if completely verified,

FOSSIL CHESTNUT LEAF (*Castanea dolichophylla*). Close to the leaf is also seen a small freshwater shell (*Planorbis florissantensis*).

would greatly affect our ideas of the process of evolution; but the chief need at present is for more light, derived from more and more diverse groups of animals. Hence the study of the fossil insects, at first seeming of purely entomological interest, is likely to lead to results of the first importance.

While we thus search for trends of evolution, we note also the great conservatism of insect types. It is well known that warm-blooded animals have undergone great changes since the Miocene, one of them being the evolution of man himself. In the case of the insects, however, the modifications have been slight indeed, even where these have been driven far and wide by adverse changes of climate.

We find, it is true, a fair number of extinct genera; types which no longer persist in the modern world; but these appear to be merely those which have died out, not the ancestors of any modern kinds. None of

the species, of course, are supposed to agree with living ones; but most of the genera agree well, except in certain groups, like the plant lice, in which there is a similar divergence throughout.

Owing to this singular constancy of fundamental structure, we are able to ascertain that some striking types now confined to particular parts of the world, were once very widely spread.

Perhaps the most remarkable instance of this sort is afforded by the tsetse fly, *Glossina*. Scudder obtained from Florissant an imperfect specimen of a large fly, which he regarded as representing a new genus and species. We were so fortunate as to secure a much better example, showing the long proboscis, and it was not difficult to recognize it as a veritable tsetse fly. The species, of course, is extinct; but the genus is the same as that now confined to Africa, where it is dreaded as the disseminator of some of the most terrible diseases known. What part the existence of such flies may have played in the destruction of the Tertiary mammalia we can only surmise; but it is not impossible that their influence was great. How it happened that they disappeared entirely from America and survived only on the Ethiopian continent is, of course, unknown.

Another discovery, hardly less interesting, was a species of Neuroptera belonging to the family Nemopteridæ. These insects are very fragile and delicate, somewhat dragon-fly-like in form, but with the most extraordinary hind wings—consisting of a long narrow stalk, with a dark-fiddle-shaped expansion at the end. One species of this family has been found in Chile, while others are known from the warmer parts of the old world. The whole group has become extinct in North America, but the fossil proves that it once existed there. Such a fossil as this not merely throws a flood of light on the past migrations of a peculiar group, but is the first and only indication we have of the past history of its race.

Florissant is famous for its fossil butterflies, having nearly half of the number known in that condition. My wife was particularly anxious to find a fossil butterfly, and often as we went out to work, we asked, would this be the day to yield the coveted treasure? Yet all the first season passed, and no butterfly was obtained. Toward the close of the second season, however, my wife sat down one day at a new place, to see what it might be worth. She had scarcely begun to turn over the shale when, behold, a truly magnificent specimen! It showed the upper wings, the body and one antenna, the spotting still plainly visible upon the wings. It proved to be an undescribed species, but of a genus still existing in Colorado, though more common southward. When compared with the Scudder collection, it was seen to be the second finest of the butterflies, yielding place only to Scudder's in-

comparable *Prodryas persephone*. During the same season we secured a second butterfly, much larger, but very poorly preserved.

When the fine butterfly was discovered, it was naturally expected that the new locality would yield other like treasures. Alas! it was worked all one day, with practically no result. Such are the fortunes of fossil hunting. While the first season yielded no butterfly, it did produce a wonderfully preserved caterpillar, still showing the bristles it bore in life. It is not the usual custom to describe a lepidopterous insect from the caterpillar alone; but in this case we had no option, since it could not be ignored, and it certainly could not be raised to maturity! Its characters were peculiar, so that it did not fit comfortably into any modern family, so far as we were able to judge.

FOSSIL NEUROPTEROUS INSECT (*Halter americana*) of a Family not now found in North America. (Much enlarged.)

Among the plants, one great treasure was a branch of the narrow-leafed cottonwood, with about ten leaves upon it. Although the leaves of this tree are exceedingly common in the shale, such a magnificent specimen is very rarely obtained. During the second season another nearly as good was found; we packed it up with the greatest care, and sent it by express to Yale University Museum, where it arrived in safety.

The large specimens, however, are not necessarily the most valuable. One small but unique object was a tuft of moss, with the fruiting bodies upon it. This was the first really recognizable moss ever found

fossil in America, and it was appropriately transmitted for study to Mrs. Britton of the New York Botanical Garden, the best authority on American mosses. It may now be seen in the great Botanical Museum in Bronx Park.

Flowers and fruits are quite numerous in the shale, though, unfortunately, nearly always detached from the plants, so that they can not be correlated with the leaves. Some of them are very well preserved and easily recognizable; others, even though reasonably perfect, have puzzled all the botanists who have examined them. One curious specimen is a bean pod, with most of the beans still in it, but one just in the act of falling out. Grass-seeds are often found, and we have one which had just begun to sprout when it was overwhelmed by a fall of ash.

CRIMES OF VIOLENCE IN CHICAGO AND IN GREATER NEW YORK

By MAYNARD SHIPLEY

RENO, NEV.

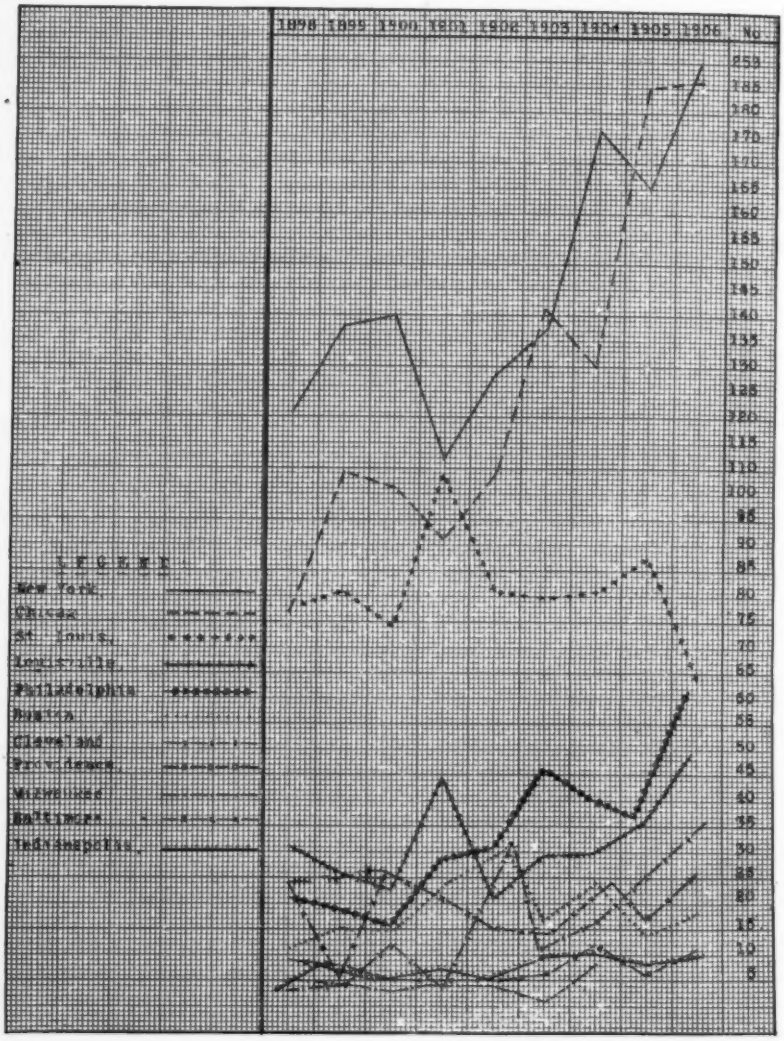
"HUMAN life is the cheapest thing in Chicago," recently declared Judge Cleland. "This city," he asserted, "witnesses a murder for every day in the year." Now 365 homicides a year would mean, for Chicago, that one out of every 5,614 of her citizens is destined to be murdered each year; or, in other words, that 17 in each 100,000 of the population would annually meet death at the hands of a fellow citizen. This would place Chicago on a criminal level with Lexington, Ky., where nearly 39 per cent. of the population are negroes. In Chicago the negro element forms scarcely 2 per cent. of the total inhabitants. As a matter of fact, however, whereas Lexington stands first in the scale of American cities in respect to the ratio of deaths by homicide to total population, Chicago stands about eighth in the list, showing a lower record for homicides than either San Francisco or Los Angeles, as may be seen in the accompanying table.

TABLE SHOWING THE ANNUAL AVERAGE OF DEATHS BY AND ARRESTS FOR HOMICIDE IN EACH 100,000 OF POPULATION, IN VARIOUS CITIES OF THE UNITED STATES, BASED ON REPORTS OF HEALTH OFFICERS AND OF CHIEFS OF POLICE. (Most of the averages given are for a period of six years.)

City	Annual Average of Deaths by Homicide per 100,000 of Population	Annual Average of Arrests for Homicide per 100,000 of Population
Lexington, Ky.	17.77	40.07
Kansas, Kan.	17.64	18.27
Louisville, Ky.	14.85	17.41
Cincinnati, O.[1]	14.28	6.9C
St. Louis, Mo.	14.16	11.30
San Francisco, Cal.	9.25	19.69
Los Angeles, Cal.	9.00	4.86
Chicago, Ill.	7.30	6.87
Cleveland, O.	6.12	9.56
Greater New York	4.93	13.23
Indianapolis, Ind.	4.18	4.74
Providence, R. I.	3.59	1.70
Baltimore, Md.	3.39	7.74
Philadelphia, Pa.	3.27	4.93
Boston, Mass.	3.13	1.98
St. Paul, Minn.	2.32	2.13
Newark, N. J.[2]	1.50	9.16
Milwaukee, Wis.	1.45	1.77

[1] As the Census estimate of population is too low, the ratio of deaths by homicide is proportionately too high.

[2] Probably incomplete returns on number of deaths by homicide.



The annual average ratio of deaths by homicide in Chicago, as given in the table, is, for the six years 1901–06, 7.30 per 100,000 of inhabitants. The minimum for these years was 5.23, in 1901; the maximum was 9.26, in 1905, the ratio for 1906 being 9.17. The maximum for San Francisco was 11.90, in 1902; and for Cleveland, 8.57, in 1906. From these figures it may be seen that the "carnival of crime" in Chicago, in 1906, did not by any means place the Windy City in the lead as a "Scarlet City." While it is true that crimes of violence are increasing in Chicago faster than the growth of population, the augmentation has been gradual, and no greater, relatively, than in Philadelphia, Cincinnati, Cleveland, Louisville, Los Angeles

ANNUAL NUMBER OF DEATHS BY HOMICIDE IN VARIOUS CITIES DURING NINE YEARS—1898–1906

	1898	1899	1900	1901	1902	1903	1904	1905	1906
New York	121	137	140	112	127	137	176	165	253
Chicago	77	108	102	92	108	142	130	185	187
St. Louis	78	81	74	109	82	80	82	87	63
Louisville	32	26	23	44	22	29	30	36	48
Philadelphia	22	18	16	28	32	46	40	37	62
Boston	12	15	15	23	31	17	24	14	18
Cleveland	3	4	12	4	32	11	16	24	36
Baltimore	24	5	26	21	15	14	24	17	26
Indianapolis	3	8	5	7	5	9	10	8	10
Providence	9	8	5	5	5	6	12	6	11
Milwaukee	5	4	3	4	4	2	8	?	?
Los Angeles	?	?	?	?	12	9	11	24	20
Lexington	?	?	?	4	4	6	5	6	6
Newark	?	?	?	?	5	3	5	3	9
St. Paul	?	?	1	10	1	5	6	6	1
San Francisco	27	32	?	?	43	36	?	?	?

and many other cities. If the number of homicides, in proportion to population, was much higher in 1905 and in 1906 than in 1901 and 1902, such an increase is by no means unprecedented, nor are such annual variations from the average unusual either in Chicago or elsewhere. Already in 1888, the proportion of murders to the number of inhabitants was almost as "alarming" as in 1905, and the ratio was even then higher than it was to be as late as 1903, being 8.09 in the year 1888, and but 5.88 in 1902. As late as 1904 the ratio was only 6.72. Again, while the ratio was 9.17 in 1906, it was 8.38 as far back as 1893, and 7.24 in 1886, which is just about equal to the average for the six years ending with 1906. Taking a period of thirty-five years, the increase in deaths by homicide has been as follows: For the period 1872–79 (eight years), the annual average ratio was 3.20; for the thirteen years 1880–1892, 5.55; for the fourteen years 1893–1906, 7.19 homicides per one hundred thousand of population. The maximum ratio for any one year of the three periods was, 5.00 in 1873; 8.09 in 1888, and 9.26 in 1906. Of grave crimes in general, the increase of arrests was from an annual average of 243.0 per one hundred thousand of inhabitants for the three years 1901–03, to 269.1 for the three years 1904–06, an augmentation during the latter three years of 26.1 in each 100,000 of the population. This increase consists almost entirely of arrests for assaults with a deadly weapon and for assaults with intent to kill. There has been little or no increase in the proportion of arrests for burglary and robbery.

That the increase in crimes of violence in Chicago is due to the presence of a large foreign-born element of an inferior economic and social status is amply attested by the available statistics. For instance, the police records for 1905 show that whereas the ratio of arrests per

100,000 of population among native whites for murder and murderous assaults was 94.16, among the foreign white population the ratio was 146.65 per one hundred thousand. Among the negroes the ratio was 107.52.

In considering the above statistics, the fact should be borne in mind that the greater frequency of crimes of violence among certain elements of the foreign-born population does not imply an inherent and ineradicable viciousness or criminality among these unfortunate immigrants, but merely a lawlessness due to unfavorable environment and inadequate education, mental and manual. Crime is twin brother to poverty, and both are the children of ignorance and greed.

It may be said, in conclusion, that while crimes of violence have increased in Chicago during the past thirty-five years, the increase has not been so great as has been represented, and that the alarming reports sent out about the "carnival of crime" in Chicago are usually without especial significance, since crimes of violence occur in all great cities sporadically, generally in quick succession. At the end of the year it is found, as a rule, that no unusual increase for the twelve months has taken place, or that even an actual decrease has occurred, as was the case in Chicago during the year 1906.

For the past four or five years the American public has been startled by sensational reports regarding "the terrible increase of crime in New York City." The year 1906 brought the usual quota of comment and criticism. More recently the apparently unprovoked killing of a policeman by an Italian assassin has focused attention upon the fact that at least 1,600 of the foreign-born element of the great metropolis have been permitted to go about the streets armed with a deadly weapon. This evil practise is tolerated more or less in nearly all our great cities, and with the same disastrous results. New York, Chicago, Cleveland, Cincinnati, Philadelphia and other rapidly growing cities, nearly all show an increase in the proportion of crimes of violence commensurate with the changing character of their immigrant population.[1] But, contrary to popular opinion, the increase of homicide in New York City has been very slight during the past decade, the year 1906 excepted. This agrees with the fact that the racial composition of the population has not materially changed during the five or six years preceding 1905. Taking a longer period, however, we find quite an increase in the number of crimes of violence, especially assaults with a deadly weapon, and, apparently, murder and attempts thereat. In 1880, when less than ten per cent. of New York's alien population was drawn from Russia and southern Europe,

[1] The extent of this change was partially traced by the present writer in an article on "The Effects of Immigration on Homicide in American Cities," POPULAR SCIENCE MONTHLY, August, 1906.

with less than three per cent. from Italy, the number of arrests for the various forms (or degrees) of homicide was less than four in each one hundred thousand of the population. In 1890, when over 30 per cent. of immigrants were from Russia or southern Europe, there were nearly seven such arrests in an equal number of residents. In 1900, the percentage of aliens of this socially and economically inferior type had reached nearly seven tenths of the total volume of immigration, while the ratio of arrests on the charge of killing a fellow-man had increased to 13 per one hundred thousand of inhabitants. In 1906, the ratio rose to 21.51 per one hundred thousand of population. Meanwhile, in other large cities of the Empire State, such as Buffalo, Rochester and Syracuse, where the foreign-born population was derived almost entirely from northern Europe, no increase in the proportion of homicides to total population has been noted. In Syracuse there have been but six cases of homicide under jurisdiction of the police department in a period of fourteen years.

ANNUAL NUMBER, AND PROPORTION PER ONE HUNDRED THOUSAND OF THE POPULATION, OF DEATHS BY HOMICIDE; AND ANNUAL NUMBER OF ARRESTS MADE FOR MURDER, MANSLAUGHTER, HOMICIDE AND INFANTICIDE, DURING THE NINE YEARS 1898–1906

	1898	1899	1900	1901	1902	1903	1904	1905	1906
Arrests for murder, manslaughter, homicide and infanticide.	347	406	451	429	517	582	630	737	885
Deaths by homicide.	121	137	140	112	127	137	176	165	253
Deaths by homicide per 100,000 of population.	3.80	4.12	4.07	3.15	3.46	3.62	4.52	4.12	6.15
	For the Six Years 1898–1903						1904–06		
Annual average ratio per 100,000 of population.	3.70						4.93		

It is worthy of note that while the number of homicides in New York City has greatly increased during the past thirty-six years, there has been no increase, to speak of, in the ratio of convicts to total population, held in the state prisons for murder and manslaughter. In 1880, there were 5.50 in each one hundred thousand of the population held for murder or manslaughter; in 1890, 7.36; in 1906, 5.78 per one hundred thousand of population. This may be partly due to the fact that the police force of New York City, where about one third of the homicides of the whole state are committed, has grown steadily smaller relative to the growth of population. Coroner Peter B. Acritelli de-

clares that "only one in ten murders and assaults is followed by arrests." Moreover, he states that, "Even when an arrest has been made, when the case comes to trial the Italian witnesses either mysteriously lose their memories or disappear until the trial is over." The Italian of southern Italy thinks there is something unmanly in an appeal to the law, and that it is the duty and privilege of every man to right his own wrongs.

While the police court records show an increase in the number of arrests for the various forms of homicide from 347 in 1898, to 517 in 1902, and to 885 in 1906, these figures do not represent a proportionate increase in the number of deaths by homicide, as may be seen by the accompanying table.

From the foregoing figures it may be seen that the ratio of deaths by homicide to total population was the same in 1905 (4.12) as it was six years earlier, in 1899; and that whereas the annual average ratio for the six years 1898–1903 was 3.70 per one hundred thousand of inhabitants, the average annual ratio for the three years 1904–06 was 4.93. Such an increase is hardly sensational. In the matter of the more serious crimes in general, such as robbery, burglary, arson, felonious assault and the various forms of homicide, taken altogether, the increase was from 120.9 per one hundred thousand of population, to 166.3 (in 1905); an increase of 45.4 in each 100,000 of inhabitants. The greatest increase to be noted is in the number of arrests for felonious assault.

That a large share of the more grave forms of criminality is perpetrated by certain elements of New York's alien population is easily demonstrated. Thus, of the 4,124 aliens held for grave crime in the penal institutions of the United States in 1904, one fourth were detained in the prisons of the empire state. It is also a significant fact that of the ninety-one persons who met death at the hands of a fellowman in the borough of Manhattan, in 1905, thirty-eight only were born in this country, and the parents of twenty of these were foreign-born. Of the 71 foreigners who were killed, twenty, or 28 per cent., were Italians, though eleven other nationalities were represented. Seven of the deceased were Chinamen (who are, in this country, more murderous in proportion to their numbers than the Italians); six of the deceased were Russians, five were natives of Ireland, four were Germans. No other nationality was represented by more than two victims. It is thus apparent how few of those murdered were native Americans of native-born parents. It is, perhaps, not too much to say that the lives of the better classes of citizens in New York City are as safe now as in previous decades, most of the deaths by homicide being confined to the immigrant quarters, the result of quarrels, of family or *tong* feuds, rather than of cold-blooded murder, for gain. Coroner

Peter B. Acritelli states that "Two thirds of the list of homicides in the Tombs are men of Italian birth." And doubtless nine tenths of these are from Sicily, Sardinia or southern Italy, since the natives of northern Italy are not given to crimes of violence; human life being safer in Venice or Florence than in Boston or Philadelphia; more secure in Milan, Turin or Genoa than in Cleveland, Chicago or San Francisco.

The accompanying table shows the comparative security of human life in various cities, and reveals the fact that the life of the average citizen is as safe in New York as in most urban communities.

TABLE SHOWING THE AVERAGE ANNUAL RATIO OF DEATHS BY HOMICIDE PER 100,000 OF POPULATION IN VARIOUS CITIES, BASED UPON OFFICIAL REPORTS

City	Annual Average of Homicides per 100,000 Population	Period
Mexico, Mex.	70.72	1899
Girgenti, Sicily	40.48	1897–1899
Sassari, Sardinia	38.64	1897–1899
Lima, Peru	36.60	1899–1900
La Paz, Bolivia	33.71	1902
Naples, Italy	29.23	1879–1899
Lexington, Ky.	17.77	1901–1905
Kansas, Kan.	17.64	1904–1905
Louisville, Ky.	14.85	1901–1905
St. Louis, Mo.	14.16	1900–1904
Rome, Italy	13.81	1897–1899
San Francisco, Cal.	9.00	1899–1903
Chicago, Ill.	7.03	1893–1904
Turin, Italy	6.56	1897–1899
Budapest, Hungary	6.13	1895–1901
Cleveland, O.	6.12	1904–1906
Genoa, Italy	5.83	1897–1899
New York, N. Y.	4.93	1904–1906
Providence, R. I.	3.59	1900–1904
Baltimore, Md.	3.39	1901–1905
Milan, Italy	3.20	1897–1899
Philadelphia, Pa.	3.27	1904–1906
Boston, Mass.	3.13	1904–1906
Venice, Italy	2.82	1897–1899
Newark, N. J.	1.50	1902–1904
Milwaukee, Wis.	1.45	1898–1904

In regard to the reputed increase of highway robbery in Greater New York, the police records would seem to show that no such increase has taken place. In comparing the number of crimes annually committed in New York City, it should be borne in mind that the population increases at the rate of nearly 113,000 yearly. As to the increase of highway robbery, the police court records merely show that the number of such crimes is far greater in some years than in others. This is true of all our great cities. We may note, for example, that there were thirteen times more arrests made in Baltimore for highway robbery in 1903 than in 1901; in Newark, there were fifteen times more arrests

for this offense in 1902 than in 1900, though the average for a period of six years shows only a slight increase in any of our cities, years of frequent arrests on this charge alternating with few, or, as in Baltimore, in some years, none at all on this charge. The number of such arrests in New York in 1899 was nine, in 1901, thirty-four, followed in 1903 by nine only. As a matter of fact, New York is one of the few cities in the union which show an actual decrease in the number of arrests for highway robbery. The official records show that whereas the annual average of arrests on this charge for the six years 1898–1903 was 19.3, for the three years 1904–06 the average was 16.7. Meanwhile, the population of New York had increased by about one million inhabitants. Arrests on the charge of arson show a very material increase, from an annual average of 26.0 for the six years 1898–1903, to 35.2 for the three years 1904–06. Arrests on the charge of felonious assault increased from 1,480 in 1898, to 3,375 in 1906. A proportionate increase in crimes of violence has occurred in nearly all cities of the union whose rapid growth is largely due to immigration from southern Europe and Italy. On the whole, the increase has been greater in Philadelphia than in New York. Boston and St. Louis are the only large cities that show an actual decrease in the number of deaths by homicide.

The chief encouragement to acts of violence in all the cities which show an increase of felonious assaults and homicides is a deplorably inadequate police force. Despite the fact that the growth of most of our cities is due to the immigration of a socially inferior type of citizenship, the strength of the police force is, in proportion to population and extent of ground to be patrolled, becoming smaller each year. If crimes of violence are far less frequent in London, Paris and Berlin, it is also true that the police and detective forces of these cities are, relative to population, much larger. And what is more important still, those who are held responsible for efficiency and discipline are free from political interference and the domination of office-holders.

THE MOVEMENT TOWARDS "PHYSIOLOGICAL" PSYCHOLOGY. III

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V

LOTZE'S (1817–81) career as an author opened in 1841, and his psychological contributions relevant to the present theme came to an end practically in 1852. Thereafter, save for a few articles,[1] he devoted himself to the elaboration of his highly significant philosophical system. He therefore antedated the work of Helmholtz. A prominent figure in the bitter controversy over vitalism and materialism (1847–60), he suffered grave misunderstanding; nevertheless, thanks to lapse of time, his psychological position admits of no doubt.

The son of a physician, Lotze entered the University of Leipzig to prepare for the paternal profession. Under the influence of Weisse he became interested in philosophy, and, upon graduation, qualified as *Docent* in both the medical and philosophical faculties. Till 1852 the studies proper to the former predominated, philosophy claimed him later, and his system represents more symptomatically than any other the stress resultant upon the cross-currents of modern thought. It is meaningful that he occupied successively Herbart's chair at Göttingen and Hegel's at Berlin.

In 1842 he took a decided stand, or even lead, in the vitalist controversy,[2] and also published his "General Pathology and Therapeutics as Mechanical Sciences." His "General Physiology of the Corporeal Life" appeared in 1851 and, in the next year, the work of importance for us now—"Medical Psychology, or Physiology of the Soul." Viewed in the perspective of cultural development, especially in Germany, his position seems to me quite evident. Here is his own statement of it:

> We have two kinds of scientific knowledge. We know, on the one hand, nature, the essence of the object studied; on the other hand, we know only the external relations that are possible between it and other objects. In the first kind of knowledge, there is a possible question of a *cognitio rei* only when our intelligence apprehends an object, not simply under the form of external being, but in an intuition so immediate that we are able, by our senses and ideas, to

[1] Cf. "Formation de la notion d'espace" in *Revue Philosophique*, Vol. IV., pp. 345 ff.; appendix to Stumpf's "Ueber den psychologischen Ursprung d. Raumvorstellung" (1873); "Metaphysik," Bk. II., Chap. IV.; "Grundzüge d. Psychologie" (posthumous).

[2] Leben u. Lebenskraft, in Wagner's "Handwörterbuch," 1842.

penetrate its peculiar nature, and consequently, to know what ought to be, according to its internal and specific essence, the order of such a being. On the contrary, the other kind of scientific knowledge, the external, *cognitio circa rem*, does not penetrate to the essence of things, but consists mainly in a clear and precise apprehension of the conditions under which the object manifests itself to us, and under which, in consequence of its variable relations to other objects, it is regularly transformed.[3]

Prior to Lotze's generation, philosophy had shaped scientific learning, leaving, at the same time, a large field open only to strict scientific treatment. In his person, science shapes philosophy, leaving, at the same time, a large field open only to strict philosophical treatment.[4] One is surprised that such a simple explanation should have escaped notice, and that a presentation of Lotze so fantastic—almost impertinent—as that of Ribot, for example, should have been perpetrated. Lotze's ability to see both sides of a problem, and his consequent sense for the limits of physiological psychology (which, in my humble judgment, remains completely justified still in essentials), provide the clue to his attitude. So, he really presents two kinds of psychology. One would investigate the factors, combinations and mechanism of consciousness; the other would consider the import of consciousness, and the end (if any) which it subserves in the universe. To understand the latter it is necessary to master his very subtle cosmology ("Metaphysics," Bk. II.). The former *is* physiological psychology, and has been presented more particularly in Bks. II. and III. of the "Medical Psychology." Here Lotze writes as a scientific man, and the "conception of a psychophysical mechanism" suffices; that is, physical, chemical and physiological causality rules. Thus, he regards "physiology of the soul as an exposition of the mechanical conditions to which, according to our observation, the life of the soul is attached."[5] "The conception of a psychophysical mechanism can be stated as follows: As ideas, volitions and other mental states can not be compared with the quantitative and special properties of matter, but as, nevertheless, the latter seem to follow upon the former, it is evident that two essentially different, totally disparate, series of processes, one bodily and one mental, run parallel to each other. In the intensive quality of a mental process the extensive definiteness of the material process can never be found; but if the one is to call forth the other, the proportionality between them must be secured through a connection which appears to be extrinsic to both. There must exist general laws, which ensure that with a modification (a) of the mental substance a modification (b) of the bodily substance shall be connected, and it is only in

[3] "Med. Psych.," Vol. I., p. 50.

[4] Cf. Rehnisch in *Rev. Philos.*, XII., 321 ff.; Achelis in *Vierteljahrs. f. wiss. Phil.*, 1882.

[5] "Kleine Schriften," II., p. 204.

consequence of this independent rule, and not through its own power and impulse, that a change in the soul produces a corresponding one in the body. . . . It is quite indifferent to medicine wherein the mysterious union of soul and body consists, as this is the constant event which lies equally at the bottom of all phenomena. But it is of the greatest interest to medicine to know what affections of the soul are connected in that mysterious manner with what affections of the body." [6] Accordingly, his phenomenal psychology was guided by competent knowledge of physics and physiology, the latter, as we must recall, being a subject which he actually professed. His speculative psychology, dealing with the mysterious union, falls within his philosophy.

The third book of the "Medical Psychology," which still conveys lessons to the physician, deals with subjects such as sleep, attention, emotion, the influence of the flow of consciousness upon secretion, nutrition, and instinct, and with abnormal psychology. The second book reviews the factors of self-consciousness, especially in the light of the relation between the physiological mechanism and the mind. It thus includes his most distinctive contribution to physiological psychology—the famous theory of "local signs." This is an integral part of his analysis of space-perception, one of the subtlest ever formulated. His latest presentation of it runs thus:

> Let it be assumed that the soul once for all lies under the necessity of mentally presenting a certain manifold as in juxtaposition in space; How does it come to localize every individual impression at a definite place in the space intuited by it, in such manner that the entire image thus intuited is similar to the external object which acted on the eye?
>
> Obviously, such a clue must lie in the impressions themselves. The simple quality of the sensation "green" or "red" does not, however, contain it; for every such color can in turn appear at every point in space, and on this account does not, of itself, require always to be referred to the one definite point.
>
> We now remind ourselves, however, that the carefulness with which the regular position on the retina of the particular excitations is secured, can not be without a purpose. To be sure, an impression is not *seen* at a definite point on account of its *being situated* at such a point; but it may perhaps by means of this definite situation *act* on the soul otherwise than if it were elsewhere situated.
>
> Accordingly we conceive of this in the following way: Every impression of color "r"—for example, red—produces on all places of the retina, which it reaches, the same sensation of redness. In addition to this, however, it produces on each of these different places, a, b, c, a certain accessory impression, α, β, γ, which is independent of the nature of the color seen, and dependent merely on the nature of the place excited. This second local impression would therefore be associated with every impression of color "r," in such a manner that $r\alpha$ signifies a red that acts on the point a, $r\beta$ signifies the same red in case it acts on the point b. These associated accessory impressions would, accordingly,

[6] *Ibid.*, I., pp. 193–97.

render for the soul the clue, by following which it transposes the same red, now to one, now to another spot, or simultaneously to different spots in the space intuited by it.

In order, however, that this may take place in a methodical way, these accessory impressions must be completely different from the main impressions, the colors, and must not disturb the latter. They must be, however, not merely of the same kind among themselves, but wholly definite members of a series or system of series; so that for every impression "r" there may be assigned, by the aid of this adjoined "local sign," not merely a particular, but a quite definite spot among all the rest of the impressions. The foregoing is the theory of "Local Signs."[7]

The best anatomical and physiological researches fail to reveal spatial order as inherent in sensation; and, even if this ignorance be due to the impossibility of following up the evolutionary regress, it is a real difficulty. Lotze therefore concluded that "localization in space belongs to the unconscious product of the soul's action through the mechanism of its internal states."[8] We gain a *field* of *vision* from an *ensemble* of local signs, and, as concerns tactile sense, the same thing happens, the functions of the corpuscles of touch being like those of the cones and rods of the retina in sight. As a result, our notion of the extended originates in a perception of *qualitative* differences, from which the mind, by its own power of transformation, constructs extensive relations. Later researches into the structure of the peripheral nerve terminations seem to confirm, rather than undermine, the hypothesis. That it is a typical example of the limitations of hypothesis Lotze acknowledged quite frankly. But he claimed, with justice, that it explained the actual phenomena better than any other theory. As a consequence, even if modified, it has been incorporated in physiological psychology, and, especially as regards vision and touch, must be reckoned with still.[9] To sum up—the point is this: Lotze held that every sensation, say, of color, was accompanied by an "accessory impression" of locality. The facts made it necessary to assume this "accessory impression." Now, just because it happens to be an assumption, it lies open to several interpretations. In other words, the principle of the hypothesis may stand, but opinions as to the way in which it may be read can differ widely. However this may be, more than any other psychologist, he has laid bare the numerous pitfalls surrounding the explanation of a psychological fact so obvious and common as space perception.

Nascent sciences present a certain family likeness in their life

[7] "Grundzüge d. Psychologie" (1881); Eng. trans. (from ed. of 1884), pp. 51 ff.

[8] "Med. Psych.," Bk. II., Sect. 294.

[9] Cf. "Elements of Physiological Psychology," Ladd, pp. 396 ff.; "Principles of Psychology," James, Vol. II., pp. 157 f.; "German Psychology of To-day," Ribot, p. 95 (Eng. trans.).

history. Commonly, they begin as special inquiries, somewhat off the traditional lines, in the science which bears close or closest affinity to the future discipline. Such movements continue lonely for a time, systematization being difficult or unattainable till many facts have been collected. To the point reached now we see this stage predominating in physiological psychology. Physics and anatomy, physiology and philosophy present special departures toward psychology, but a unification of the last still lacks. The final step must be associated always with the names of Gustav Theodor Fechner and Wilhelm Wundt (the latter more emphatically), who, building on the accumulations of their predecessors, at length brought the new science into formal shape.

Fechner (1801–87), like Lotze, studied medicine at Leipzig, where he became professor of physics in 1834. Like Lotze, too, he was an expert in philosophy. Both were "masters in the use of exact methods, yet at the same time with their whole souls devoted to the highest questions, and superior to their contemporaries in breadth of view as in the importance and range of their leading ideas—Fechner a dreamer and sober investigator by turns, Lotze with a gentle hand reconciling the antitheses in life and science."[10] In a fashion Fechner's psychology is more intimately connected with his philosophy than Lotze's, and his philosophico-psychological perspective offers points of strong contrast to Wundt's. Indeed, his definition of psychophysics—a term original with him—hints as much. "I understand by psychophysics an exact theory of the relations of soul and body, and, in a general way, of the physical world and the psychical world." Undoubtedly, the psychology may be disengaged from metaphysical entanglements, as Wundt said in his address on the occasion of the Fechner centenary.[11] But, after all, Fechner's panpsychism forms a motive force of his psychophysics, because, intellectually, he was a double personality.[12] His philosophical theory teaches a universal parallelism between the physical and the psychical. Or, as Nägeli, the botanist, has it:

> Sensation is clearly connected with the reflex actions of higher animals. We are obliged to concede it to the other animals also, and we have no grounds for denying it to plants and inorganic bodies. The sensation arouses in us a condition of comfort and discomfort. In general, the feeling of pleasure arises when the natural impulses are satisfied, the feeling of pain, when they are not satisfied. Since all material processes are composed of movements of molecules and elementary atoms, pleasure and pain must have its seat in these particles. Sensation is a property of the albuminous molecules; and if it belongs to these, we are obliged to concede it to the other substances also. If the molecules possess anything even remotely akin to sensation, they must have a feeling of comfort when they can obey the law of attraction or repulsion, the law of their own inclination or aversion; a feeling of discomfort, however, when they are

[10] "History of Modern Philosophy," Falckenberg, pp. 601–2 (Eng. trans.).
[11] Cf. "Gustav Theodor Fechner," K. Lasswitz, p. 91.
[12] Cf. *ibid.*, p. 154.

compelled to make contrary movements. Thus the same thread runs through all material phenomena. The human mind is nothing but the highest development on our earth of the mental processes which universally animate and move nature.[13]

Fechner had worked out this fundamental theory ere he arrived at his psychological results. We find glimmerings of it so soon as 1835, in the attractive "Little Book on Life After Death," in the tract "On the Highest Good" (1846); enlarged views in "Nanna, or the Soul-life of Plants" (1848); while the system appears full-fledged in "Zend-Avesta, or the Things of Heaven and the Hereafter" (1851); in 1861 he returned to it in his book, "On the Soul Question," occasioned by contemporary materialism, and in "The Three Motives and Grounds of Belief"; and in 1879 he reaffirmed and restated the position in the remarkable volume entitled "The Day View and the Night View." The essence of his teaching may be summed up in the thought that the material or external world is a half-truth, a concession to the sensuous, rather than an explanation of the psychical;

However complicated our brains may be, and however much we may feel inclined to attach to such a complexity the highest mental properties, the world is unspeakably more complex, since it is a complication of all the complications contained in it, the brains among them. Why not, therefore, attach still higher mental properties to this greater complexity? The form and structure of the heavens seem simple only when we consider the large masses and not their details and concatenation. The heavenly bodies are not crude homogeneous lumps; and the most diverse and complicated relations of light and gravity obtain between them. That, however, the plurality in the world is also grouped, comprehended, and organized into unity does not contradict the thought that it is also comprehended into a corresponding mental unity, but is in harmony with the same.[14]

Consequently, the physical symbolizes the psychical. They are two faces of a single existence. Human research may, therefore, deal with the one or the other, and attain, as it has attained, great success. But the real problem centers in the relation between the two. Of this, physiological psychology is *the* science. You can, accordingly, pursue it *quâ* science, but you must never forget the larger setting in which it finds itself.

Proceeding to the psychology, then, note at once that Fechner envisages the problem rather as a physicist than as a physiologist. So, he suffers from his limitations, but gains in precision. Soul and body being a single existence, it is practicable to investigate their mutual functioning and to state the results as laws of nature, which, in turn, are no more than assemblages of observations concerning phenomenal

[13] Cf. "Die mechanische-physiologische Theorie d. Abstammungslehre" (1884).

[14] "Ideen zu einer Schöpfungsgeschichte," p. 106.

existence. Of course, a developed psychology would endeavor to extend this plan to the entire range of consciousness. Fechner, however, confines himself to a single fundamental point—the relation between stimulus and sensation as generalized in Weber's law; although, just as Lotze before him, he considers other questions in a most suggestive manner, such, notably, as the seat of the soul, sleep and reminiscence. In pursuance of his early conviction, that soul and body are but opposite sides of an identical existence (conscious), he took it for granted that their reciprocal action would be proportional. But this was belief, not science. Weber's work led Fechner to test the hypothesis, that the increase of physiological excitation holds the key to psychological changes. And his interest was stimulated by the fact that, if this could be proved accurately, his philosophy would benefit by so much indubitable evidence. Consequently, he was moved to verify Weber's law by numerous experiments, chiefly of a *physical* sort. Sensations of pressure and muscular effort, detected by the use of weights; sensations of temperature, determined by cold and hot water; sensations of light, handled by the photometer; and sensations of sound, observed by reference to falling bodies, all tended to confirm the same general relation between stimulus and the psychological event. Given what Herbart called a "threshold of sensation," and having fixed this as a constant for each class of sensation, Fechner found it possible to infer, by strict induction, that the intensity of the sensation is equal to the *proportion* of the stimulus, multiplied by the logarithm of the excitation, divided by the threshold of stimulus. In other words, we *can* obtain a formula for the *quantitative* relation of physical and psychological events considered as magnitudes. This formula, which provides a means of measurement, declares that the sensations increase proportionally to the logarithm of the stimulus.[15] As a law, Fechner affirms dogmatically that it applies for internal (psychological) states and, within limits, reasons for which can be given, for external (physiological or physical) conditions. The result was obtained by three methods. (1) The Method of Differences which are Just Observable. This means that the operator finds, first, the least greater or the least smaller stimulus which can just be sensed as different by the subject; and then proceeds to add increments to this, or, inversely to subtract increments from it, till the intensity or diminution come into clear recognition. Divide the sum of the initial and the altered stimulus and you arrive at the differential of sensibility. (2) The Method of True (Right) and False (Wrong) Cases. Here the operator applies two stimuli, which differ slightly, to the subject, and inquires whether the first is greater

[15] Cf. "German Psychology of To-day," Ribot, pp. 138 f. (Eng. trans.); "Outlines of Psychology," Külpe, pp. 164 f.; Ward in *Mind*, Vol. I. (old series), pp. 452 ff.; or in any standard psychology, *e. g.*, James or Wundt or Ladd.

or smaller than the second. The replies are recorded; the ratio of true judgments to the total number of judgments gives the measure of sensibility, and varies directly with it. (3) The Method of Mean Errors—or of Probability of Error. Given a stimulus, the subject is asked to add another just equal to the *datum*. He deviates more or less; the probable error of the adjustment, in its deviation from the known mean, affords the direct measure of sensibility. The last, so far as an amateur can judge, would seem to be the most important, because the most accurate procedure. As has been said, the resultant generalization holds within limits, upper and lower.[16] But this is just what one anticipates in any law of nature. And there is another, much more pertinent, question. Does the law apply to the relation between sensation and neurosis, or merely to that between neurosis and excitation? If the former, it is psycho-physiological; if the latter, it is no more than physiological or, strictly, physical. Now this raises precisely *the* fundamental problem: Are sensations measurable? And this, in turn, seems to me to depend upon the possibility of differentiating between sensation and perception (the *manner* in which we experience sensation). So far as I catch the present drift, the *central* difficulty remains *sub judice*. On the other hand, if one be prepared to accept the theory that I call "organicism"—the analogue on the metaphysical side of activism on the ethical, which declares that our whole experience can only be interpreted as a single vast organism, in which every part bears a relation at once of means and end to every other, it follows plainly, in my judgment, that, if not Fechner's law, then *some* law (possibly not yet known, but necessary all the same) must be operative; and, further, that this law, in certain of its manifestations, is capable of discovery and verification by psycho-physiological methods. You see we must not demand finality from a new science in the first generation of its formal career. At this point the most pitiable errors have been made both by critics and by advocates. The critic who insists that physiological psychology has nothing to tell is in far too big a hurry to judge; and the advocate who urges that physiological psychology can tell everything forthwith deposes his own subject from its hard-earned place as a positive science. It is fair to add, as opposed to my own view, that the greatest American psychologist, Professor James,[17] states (1) that "Fechner's originality consists exclusively in the theoretic interpretation of Weber's law" (p. 545); (2) that "the entire superstructure which Fechner rears upon the facts is not only seen to be arbitrary and subjective, but in the highest

[16] Ribot, *q. s.*, p. 168; Helmholtz, "Physiol. Optik," pp. 314 f.; "Hereditary Genius," Galton; and, for a very destructive view, "Introduction to Psychological Theory," Bowne, pp. 49 ff. See also refs. under Weber's law above.

[17] Cf. "Principles of Psychology," Vol. I., Chap. XIII.

degree improbable as well" (p. 547); and (3) that "Weber's law is *probably* purely physical" (p. 548). And he concludes, "the only amusing part of it is that Fechner's critics should always feel bound, after smiting his theories hip and thigh and leaving not a stick of them standing, to wind up by saying that nevertheless to him belongs the *imperishable glory* of first formulating them and thereby turning psychology into an *exact science* (!):

> "And everybody praised the duke
> Who this great fight did win."
> "But what good came of it at last?"
> Quoth little Peterkin,
> "Why, that I can not tell," said he,
> "*But 'twas a famous victory*" (p. 549).

All of which need not be taken with too many grimaces. For it merely means that physiological psychology remains in the "natural history" stage—it is still occupied mainly in the assemblage of facts. And no one would oppose it were it not that some foolish partisans, after the fashion of fools in all ages, go about to magnify their office. That psychology can never hope to be "exact" after the kind of physics, or even, mayhap, physiology, seems beyond doubt. Yet one attaches little, if any, weight to this remark. For, as physiology ceases to be physiology when it assimilates itself to physics or to chemistry, so psychology ceases to be psychology when it attempts to become physiology, just as sociology, masquerading in the guise of psychology, is no science, but simply a homeless bastard. Sceptical as the conclusion may seem, Fechner, nevertheless, needs no justification, as his work for esthetics proves abundantly.[18] For, in psychology, as in every other science, the investigator assumes the intelligibility of nature; and then, by an attack in detail, attempts to show that natural interrelations are as his conceptual conclusions anticipated they would be. And from this process no sphere of experience can be held exempt. Doubtless, the application is most difficult in psychology, because there abstraction from either body or mind leads to positive error. But, here, again, we are only saying that, despite all its laboratories and apparatus, psychology remains that new revelation—a philosophical science. And to my mind its first-rate importance grounds exactly in this very fact.

[18] Cf. "Fechner," Lasswitz, p. 101.

THE NATURE, ORIGIN AND FUNCTION OF HUMOR

By LINUS W. KLINE, Ph.D.

I. Introduction

NO stimulus, perhaps, more mercifully and effectually breaks the surface tension of consciousness, thereby conditioning the mind for a stronger forward movement, than that of humor. It is the one universal dispensary for human kind: a medicine for the poor, a tonic for the rich, a recreation for the fatigued and a beneficent check to the strenuous. It acts as a shield to the reformer, as an entering wedge to the recluse and as a decoy for barter and trade. A German writer observes that it is a parachute to the balloon of life. To change the figure, it is a switch on the highway of life to prevent human collisions. Zenophon reckons that the man who makes an audience laugh has done a lesser service than the one who moves it to tears. But the comedian Philippos, when Socrates asked him of what he was proud, declared, "I believe that I ought to be as proud of my right to the gift of arousing laughter, as Kallipides, the tragedian, of his art in causing tears."[1]

Darwin points out that the causes of laughter are legion and exceedingly complex.[2] Humor may often be a cause, in which case it is the mental aspect of a psychophysical fact. The mental aspect, only, forms the subject matter of this paper. It offers problems for investigation similar to any other concrete mental fact. I propose to show that the character of its stimuli, the conditions of its origin in the race and in the individual, its nature and function as a mental process, are discoverable, describable and susceptible of explanation.[3]

II. The Nature of the Stimulus

(a) *Non-humorous Stimuli*

The immensity of space, the infinitude of time, the motion of the heavenly bodies and all cosmic rhythms are void of humor. The same thing is apparent of all physical, chemical and mathematical laws, and likewise of all macroscopic things of earth such as the waters, the tidal movements, the cataracts, the mountains, the forests, the deserts and

[1] Nick, Fr., "Narrenfeste," Bd. I., Zeit. 2, 1861.

[2] Darwin, Chas., "The Expression of the Emotions in Man and Animals," p. 198.

[3] The physiological conditions of laughter have been treated at length by Ewald Hecker and Herbert Spencer; the latter's contribution still remains the classic on this subject.

the plains. Swift rhythmic movements of organic life in the large, and the orderly expression of life processes, as the heart-beat, the mystery of sleep, birth and death, may inspire awe and dread, but never humor.

There is a large group of objects and actions which incite feelings of contempt, disgust and loathing, such as parasites, creeping and slimy things, filth, skin and eye diseases, all forms of tyranny, treachery, poltroonery, ingratitude and, according to Bain, "the entire catalogue of the vanities given by Solomon."

All common and customary activities and events and objects of familiar notice constitute, so far as the pleasure-pain field is concerned, an indifferent zone.

By this eliminating process it appears that the conditions averse to humor are: (1) The macroscopic things of the world, including her laws, order, harmony and rhythm, (2) those things which are inimical to life and freedom, (3) those things, largely of the social order, that have become habituated, regular in occurrence and necessary to human comfort.

(*b*) *Humorous Stimuli*

There remain for consideration: (1) Animals and their actions, (2) man, (3) his actions, (4) clothes, (5) customs and manners, (6) words, language and thought.

1. *Animals.*—The statements that "There is no comic outside of what is properly human," and that the lower life and inanimate objects provoke humor only when endowed with human qualities, are perhaps true and the many exceptions simply prove the rule. Small animals, like small people, are more likely to provoke humor than large ones. The bantams and games are the clowns and Don Quixotes of poultrydom, while the Plymouth Rocks and Shanghais are the prosaic members. The poodles, terriers and spaniels are the fun-makers of the kennel; the St. Bernards, great Danes and bulldogs command our serious respect and sometimes more. When an animal of one class does the task common to an animal of quite a different class, it is apt to provoke humor. An ox in shafts drawing a top buggy, mules, asses or buffalos running a race, an elephant drawing a chariot are examples. But if the animal is set to doing a human task the humor is intensified. The inimitable Æsop, endowing animals with human craft and qualities, made this style of humor classical for all time. It appears in modern humor in the stunts of Johnny Bear, in the clever tricks of Brer Rabbit and Brer Fox and in the county fairs, charity balls, political conventions, clinics for appendicitis and the like conducted by divers species humanly socialized.

2. *Man.*—Man may provoke humor by his size, especially if extremes meet. The undersized is likely to amuse—especially in his pre-

tensions and passions. Unusual features, types of ugliness, odd shapes, Falstaff proportions, contain humorous elements.

3. *Actions.*—Mimicry and all actions of a pretentious and useless sort and in false time and space relations may provoke humor. All mimicry is humorous, whether in the form of the puppet show, the pantomime, the burlesque or the comedy. Hazlitt calls attention to a large group of humorous acts as seen in the "pursuit of uncertain pleasure or idle gallantry." Professor James refers to the same subject in describing our desire for recognition: "We are crazy to get a visiting list which shall be large, to be able to say when any one is mentioned, 'Oh! I know him well' . . . there is a whole race of beings to-day whose passion is to keep their names in the newspaper, no matter under what heading; 'arrivals and departures,' gossip, even scandal will suit them if nothing better is to be had." Useless actions of the ideomotor and absent-minded type are the causes of many of the comedies of errors in every-day life. A young lady who had partially disrobed to make a toilet at the noon hour, wound up by "saying her prayers," that being the usual next step in the evening. A college girl stopped at her own room and knocked vigorously for admission. Forgetfulness, too, is often a source of humor. Here belong the host of stories of the forgetful and absent-minded professor, from which we select one. A certain professor asked the lady of his choice for her hand, in total disregard of the fact that he had made the same request with the happiest result on the day preceding. The wrong use of objects, tools and machinery often makes an act humorous; for instance, posting letters in a neighbor's private letter box, an Indian taking his family to church in a hearse purchased for a carriage, sharpening a hand saw by grinding the teeth out of it. Awkwardness is a common type of action naturally humorous. Any action inherently serious may become humorous by occurring out of time or out of place. Singing ahead of time or out of tune, applauding alone, answering questions at the wrong time at a marriage service, an unmindful deacon removing his small coat with his overcoat and sitting down in his shirt sleeves in church, are cases in point. Hazlitt remarks, "In Jocular history everybody is at angles to real life; people do precisely what they ought not to do, say what they ought not to say, are found where they ought not to be found."

4. *Clothes.*—Clowns and professional fools supplement their wit, humor and mimicry by their well-known forms of dress. Johnny Bull, Uncle Sam and Santa Claus are always received good-naturedly partly on account of their dress. Hallowe'en, masked balls, the Mardi Gras and Carnivals ancient and modern owe much of their charming good humor to dress. It is well known that we laugh at the dress of foreigners, and they at ours. "Three chimney sweeps meeting three Chinese in Lincoln's-inn-fields, they laughed at one another till they were ready to drop down. . . . Any one dressed in the height of

fashion or quite out of it is equally an object of ridicule." Doubtless if the centuries could rise up and view each other *en masse,* their first act would be mutual laughter at each other's clothes.

5. *Customs and Manners.*—As stimulants of humor customs and manners have, perhaps, no equal. They excite it alike in the vulgar and the cultured, in the illiterate and the learned. They appear in excesses and exaggerations and in violating time and space relations, either as innovations or as lingering too long. To appear in excess or out of time and place implies some age and stability in human institutions. Norms and standards of fashions must be formed, regularity in activities must freeze into custom and the free spirit of good-fellowship and of social intercourse must become habituated to the plane of manners before the spirit of satire, wit and humor can react for or against them. The gentle old countryman whose habit it had been to exchange the courtesies of life with his fellow travelers along the country highway, awakened a ripple of humor when he graciously shook hands with all the occupants of a city street car. Mark Twain in his "Connecticut Yankee at King Arthur's Court," gives us a charming glimpse of the humor of manners and customs out of time. Fielding observes of even so playful a dramatist as Sheridan that he attacks affectation, false sentiments, hollow forms and empty words in life and literature.

6. *Words, Language and Thought.*—This is the favorite tramping ground for both the humorist and his critic. The most delicate, subtle and refined specimens occur here. It is also here that an attempt to give an adequate treatment resembles trying to bottle a fog or lasso a cloud. To make some headway, however, we are under the necessity of drawing a few distinctions. All words, language and thought, not humorous to the speaker but so interpreted by the observer, may be termed *unconscious humor* (following the lead of common usage). The humorous interpretation of unconscious humor may be called *passive humor.* All deliberate manipulation of words, language and thoughts by the subject for humorous effects may be considered *active humor.* In what follows the text will show which sort is meant.[4] Concerning words, it appears that their misspelling, mispronunciation, misinterpretation, forced usage and misusage, punning, repetition, localisms and foreign accents endow them with a certain degree of humor. Many of the humorous classics use one or more of these methods. The writings of "Artemus Ward" and "Josh Billings" about exhaust the possibilities of misspelling. Negro, Irish and foreign dialects now occupy much of the field of mispronunciation and misinterpretation. Dickens displays the worth of forced usage in the inimitable Pickwick. Sheridan creates Mrs. Malaprop largely by these methods. Shakespeare had the courage to pun to his own satisfaction. Dickens has

[4] For a discussion of the forms of the comic see Th. Lipps, "Komik und Humor," pp. 78–102.

used repetition to a fine effect in several of his characters. We recall Mr. Totts', "of no consequence," and Joey Bagstock who is "devilishly sly." Provincialisms and foreign accents enter into the humor of daily life rather than that of literature.

The unconscious distortion of words by the illiterate, the naïve and the pretentious adds to the quality of this sort of humor. In fact, whether the distortions are "made" or are unconscious, their humor depends on our apprehending them as such. A farmer who made daily business trips to Richmond assured his neighbor that he always dined at a "first-class reservoir." A colored servant in my own home asked for a half holiday in order to go on a "railroad squashin" (excursion). (What irony in the light of recent events!)

Language much more than custom and manners requires a civilization of some age and stability in order to furnish both the conditions and material for humor. George Meredith[5] has urged that it requires a society of cultivated men and women, wherein ideas are current and of some duration and perceptions quick, that the humorist may be furnished with matter and an audience. "The semibarbarism of merely giddy communities and feverish emotional periods" creates no humor.

Quaintness in language as in other things possesses a tinge of humor. A description of the table manners of a nun or a lady of culture in modern language would be sorry business, but when Chaucer says of the nun

> At mete wel y-taught was she with-alle;
> She leet no morsel from hir lippes falle,
> Ne wette hir fingres in hir sauce depe.

He stimulates our sense of humor. Here too belong the grave and serious in connection with trivial and prosaic matters, for example the records of colonial legislative enactments and the minutes of their town meetings. Many of the failures of language to fit the thought yield humor; a common type is verbosity. In this connection I give the following:

MT. STERLING (KY.) REPORTER. (COLORED)

Dear Editor: Please allow me a space in your momentous Gazette to reciprocate my gratitude to the indefatigably workers of the Evergreen Baptist Church. While sitting in my studio last Friday evening greatly obsorbed in the monotonous problem so-called Negro problem I were interposed by the anthem, "There shall be showers of blessing" which rendered me surprisal happy. . . . After a general parlance I were divinely impressed to descant on the altronistic spirit that should characterize the christiandom. A sumptuous repast followed and all present shaiated their gastronomic desire. Bro. Ben Mitchell distinguished himself by his implacable vorasity. May God bless the members of the Evergreen Baptist Church. Many thanks. F. B.—*Pastor.*

Opposed to the quaint is the ultra-slang, brusque catch-words and phrases of common life; witness the monologues of "Chimmie Faddin" and the writings of George Ade.

[5] Meredith, George, "An Essay on Comedy," p. 8, London, 1905.

The speech of the excited, the irritated and the fatigued often becomes humorous by inversions. A prospective bridegroom at the church door in consultation with his minister inquires excitedly, "Is it kistomary to cuss the bride?" Grumio answers his master, "Ah, sir, they be ready; the oats have eaten the horses" (see "The Taming of the Shrew," Act III., Scene 2).

What a man thinks and feels, although serious to him, may be just as much an object of humor as a situation, an awkward movement or a form of speech. The unconscious maker of humor in thought is your next neighbor. Every one is a contributor on occasions to this type. Certain classes, however, are much more productive than others; among them may be mentioned the ignorant, the illiterate, the inexperienced, the credulous, the skeptic, the superstitious, the over-serious, the vain and the prosaic. Their humor appears in their attempt to deal with situations and problems somewhat beyond their ken. The ignorant and illiterate amuse by their literalisms, pretensions, evasions and superstitions. In looking over some papers written by students of Plato's Republic I noticed that they usually began the story of the Lydian shepherd, Gyges, and his magic ring, in somewhat this fashion: "A shepherd lad was tending his flock on a mountain side when suddenly a violent storm arose. The rain fell in torrents, the ground was rent asunder by an earthquake and a yawning gulf opened in the very midst of the flock. Inspired by curiosity, he descended into the gulf and among the marvelous objects he saw a hollow brazen horse," etc. One paper ran thuswise: "A shepherd one day noticed a large horse standing in a hole in the ground. He climbed inside," etc. Dickens employs pretensions in the interests of humor, as Joe Gargery's deceptive attempts at reading for Pip's benefit. Thackeray's Capt. Rawdon Crawley is a fine specimen of stupid ignorance. I am persuaded that many superstitions are kept alive by their humorous vein. To turn back is bad luck, the "spell" may be broken by making a cross in the path with the big toe and then spitting in it. A negro boy taught us this when children. We did not believe it, but practised it for fun. Inexperience is the lot of childhood, and the condition of its humor, which is expressed in the questions, in the wonderings and in the explanations of child thought. This is abundantly verified in the writings of the "pot-hunters" of childlore. The humor of the credulous appears in a condensed form in their responses to the yarn-spinner and the prank-player. The faith and works of the inventor are often ahead of his time and are therefore sometimes the butt of the common mind. Cervantes made Don Quixote the humorous peer of all time among the over-serious, and Malvolio of Twelfth Night typifies the humor of vanity among individuals of small parts. Putting great force into small matters, exercising much thought over petty ques-

tions, exalting trifles into the plane of the magnificent form perennial sources of humor.

Active Thought Humor.—This type of thought humor is as complex and infinite in variety as thought itself. Cicero was the first to have extensively considered it, and even he apologized for his number of headings. He says, "I have divided these matters into too many headings already." He includes: deceiving expectation, satirizing the tempers of others, playing humorously upon our own, comparing a thing with something worse (Bain's degradation theory), dissembling, uttering apparent absurdities, pretended misunderstandings, wishing the impossible, uniting discordant particulars (Krapelin's theory of the comic), concealed suspicion of ridicule. He illustrates the latter by "the Sicilian who, when a friend of his made lamentations to him, saying that his wife had hanged herself upon a fig tree, said, I beseech you give me some shoots of that tree, that I may plant them."

Cicero's[6] list has been considerably increased by later writers without contributing anything essentially new. I shall not attempt to increase the list. I wish here to emphasize some of the more common ways by which active thought uses the material, already detailed, in the interest of humor. Some of the simpler uses are seen in childhood in their "fooling" and playful deception. The vigorous use that the child makes of "April fool" is an example. The child employs the recognition process for humorous effects in his mimicry, drawings and riddles. To draw an object with doubtful resemblance and require an adult to identify it affords him pleasure. Constructive imagination is put to the service of humor by the various forms of roguery. A negro boy asked my brother of twelve if he had seen a stray cow. "Did she wear a small bell?" asked my brother. "Yeah, dat's de cow." "Did she have a short tail?" "Yeah, dat's de veay cow." "Then I haven't seen her." The essential principle in cartooning is to display an association formed either by evident or obscure resemblances. Both wit and humor of the highest type depend upon the power of perceiving unusual, exaggerated and remote relationships. Mark Twain stands alone in this country in the use of exaggerated relationships. Groos[7] has marshaled considerable evidence to show that the higher mental processes may be used in the service of play. Kant pointed out that play and humor are closely related, if not actually crossing each other. This suggests the notion that every process exerted in the service of play may at the same time, or under slightly different conditions, be used for purposes of humor. The making and solving of conundrums and riddles, impromptu and otherwise, are practised no less for their humor than for their play value. I hardly need mention the coarse type of active thought humor which makes a liberal use of profanity and other vulgarisms.

[6] Cicero, "Oratory and Orators," p. 304, Bohn's edition.

[7] Groos, Karl, "The Play of Man," pp. 152–158.

III. The Nature and Origin of Humor as a Mental Process

Schuetze, in 1817, and Hazlitt, in 1819, summarized the various opinions as to the nature of humor up to their time. The former cites some fifteen different authorities and views. Schopenhauer, in 1819, made a decided contribution in that he attempted an exact description of the mental processes involved. Since then the nature of the mental process and its physiological basis have been the main points of discussion. Schuetze, Hoeffding and Sully call attention to the sense of freedom involved. Penjon, in 1893, described at some length the relation of this sense to humor.

I have already pointed out that the appreciation of law, of order, of harmony and of those things that are inimical to life and freedom begets a sober mental attitude, the intensity of which varies with the weightiness of the matter and the issues involved. Now if, when dealing with such matters, the thinking process continues organized and controlled and progresses towards an end, it is termed rational. But if the mental tension exceeds the capacity for controlled thinking, brought on by the sudden triumph of wrong and evil values, disruption of the thinking process at once ensues, accompanied by an unpleasant emotion ranging from mild disappointment to the tragic; if, on the contrary, the disruption is caused by the sudden triumph of good values, a pleasant emotion results. In either case organized and rational processes give way to those of an uncontrolled and emotional sort. The mental stream has had its banks torn away and its forward movement stopped, voluntary movements are replaced by hereditary. In the more intense forms a reversion to primitive conditions may occur; for we then do and say things that may shame us in our sober moments. Now the humor process occurs in just such a disrupted consciousness induced by the triumph of good and pleasurable values preceded by a mental tension similar, but not always equal, to that preceding emotions. The common and quiet forms of humor usually occur in a consciousness that has been running at its usual strength and depth, sufficiently organized to command the situation, assume a definite form and take on a certain strength of surface tension. (The term surface tension simply extends the water metaphors of psychology in a logical direction. I use it to indicate the impervious condition of consciousness formed in any attentive state, the strength of the surface tension being in direct proportion to the intensity of attention.) The function of the humor stimulus consists in cutting the surface tension, in taking the hide off of consciousness as it were, and in breaking up in part only its organization, which is at once followed by the humor feeling—the next link in the conscious chain. The principal elements in the humor process consist (1) of the perception of the stimulus, (2) the sense of freedom, (3) its recognition. These elements are each suffused by a pleasurable tone and produce by their total synthesis the

unique humor tone. The uniqueness of the tone is the crux of the matter. The mental tension preceding the humor process, although an essential condition thereto, is not a differentium, for it precedes any and all emotional states.

The clue lies in the nature of the humor stimulus, and the relation sustained to it by the individual. This is in line with Dr. Dewey's theory of the differentia among the several emotions themselves. He holds that each emotion is marked off from other emotions by the different reactions produced by the exciting fact. I have indicated that the humor stimulus belongs to an order of knowledge whose laws, uniformities, manners and customs have arisen since the human mind has attained its present estate. Contrast with the humorous stimuli the non-humorous, and it appears, humanly speaking, that the latter has always existed. The heavens, the laws of matter, cosmic forces of whatever sort, were in full swing when human consciousness dawned, their operation has participated in mind evolution and to that extent has impressed law and order upon it. Therefore, when we are engaged with these things, sober thinking, pleasant or unpleasant emotions, are the outcome, but never humor. But it will be noticed that the humorous stimuli consist of departures, of exaggerations, even of violations of the laws, uniformities, concepts and what not that have evolved out of man's experience. The significant fact for humor is that these departures, and exaggerations do not disturb the recognized values of good and evil. The mind maintains all the while a disinterested attitude toward the object of its activity. We seek neither to correct nor further to exaggerate the departure from the normal. It is time to feel and not to act. We enter into æsthetic rather than practical relations with the object of our humor; should we seek the practical, humor at once ceases, issuing perhaps, in bitterness or joy, sarcasm or flattery, indignation or admiration.[8] Penjon,[9] writing upon this point, says:

August, 1893.

I shall have to distinguish these varieties of the comic laugh, sometimes so near to tears and often so cruel. But if one separates, as must be done, the causes which too easily deform the comic and make of it an emotion of wickedness or bitterness, the comic emotion will appear purely disinterested. I mean by this that the object or the event which is the occasion of the comic excludes every idea of loss or of profit, that it makes us conceive neither hope nor fear and seems to us at the same time neither advantageous nor harmful to any one; it is worth in itself what it is worth without adding to our idea of it any consideration of end or ideal. The comic emotion is then essentially a play emotion.

The humor process then, like play, is its own end and justification. The kinship between humor and play already indicated not only sug-

[8] For subjective proof of this one may read Benjamin Franklin's "Polly Baker's Defense"; also Dickens's satire on American life in "Martin Chuzzlewit."

[9] Penjon, A., "Le Rire et la Liberté," *Revue Philosophique*, pp. 113–140,

gests relationships between humor and freedom, which Penjon has so well worked out, and between humor and æsthetics, long ago indicated by Kant and recently by Lipps, but that mental activity so long interpreted as play should be credited to humor. I have already indicated the survival value of humor for superstitions. It doubtless performs a similar and larger function for play. Humor, then, is an end in itself. It is disinterested in its object. This fact constitutes it first differentium.

I have already indicated that the sense of freedom is a constituent element in the humor process. Its consideration is next in order. To that end I submit some of the evidence as it had formed in my own mind before meeting with Penjon's more extended account. The family and guests are seated about the fireside enjoying the moments of silence. The only light is that of the glowing embers. A smouldering bit of bark suddenly flashes up and a smile plays over the faces of the silent group. The stroke of a sweet-toned clock, or a sneeze, or the dropping and rolling of a sewing thimble or a ball of yarn produces under similar conditions the same effect. A group of boys are seated on the bank of a bathing pond apparently gazing at the water's glassy surface. Suddenly it is broken by a few drops of rain out of a cloudless sky. The boys smile. The humor in such cases is weak and simple. At such times consciousness is damped down to dreamy monotonous processes under lax attention, and the mild humor results from the sudden, delicate and harmless stimulus piercing its surface tension, disrupting its feeble structure, and permitting it to flow in a more free and spontaneous fashion. This simple type finds verification writ large in every-day life. Objects and actions of little or no inherent humor may become excruciatingly humorous under hard and tense conditions. "Snickerin' at nothin'" in the schoolroom, giggling before strangers and company, especially when at the table, the increasing intensity of the annoying return waves of humor on solemn occasions, are cases in point. Members of college glee clubs inform me that they see humor in everything while on their vacation musical tours. Darwin records that the German soldiers before the siege of Paris, after strong excitement from exposure to extreme danger, were particularly apt to burst into laughter at the smallest joke. I have received abundant reliable evidence that the sufferers of the San Francisco earthquake, while enduring intense mental strain, burst into laughter on the slightest provocation. This and like cases should not be confounded with hysteria, which may occur unaccompanied by mental strain. The history of humorous literature discloses the fact that it is most prolific in those crises and changes in human affairs at which the consciousness of freedom breaks out. The work of the cartoonist is most vigorous and poignant when official tyranny and high-handed abuses are laying heavy hands on the public. We recall the heroic

work of Th. Nast[10] during the brazen days of the Tweed Ring. Martin[11] observes that the parody was first introduced during the performance of Greek tragedies to relieve the audience from the intense mental strain. In the severe atmosphere of the king's court the court fool was an important adjunct. In reality his was the freest personality of the group, the king not excepted. A most striking example of this in literature is that of King Lear and his fool.

These considerations indicate an intimate kinship between the humor process and the sense of freedom. The real relation becomes apparent when the nature of the stimulus is taken into account. It has already been shown that the humor stimulus violates and breaks up the order and mechanism about us. It appears as the only objective fact in our experience that dares to defy the social order with impunity, that can violate ruthlessly, without pain and without apology, the human contrivances about us, and thereby not only remind us that freedom is an abiding reality, but that we may escape, temporarily at least, from the uniformities and mechanisms of life. We are rather chary of an over-scientific game, one in which luck and spontaneity are entirely supplanted by principles and rigid regulations. Speaking of a game or a contest as a "dead sure thing" is an implication that spontaneity and life are inoperative. Any instrument, therefore, that reveals freedom to us through the veil of mechanism and the social order will produce pleasure. Play, art and the humor stimulus are such instruments; play is largely for the young, art for the trained and educated, but the humor stimulus is for every one. The second differentium of the humor process, therefore, is the sense of freedom.

The failure to see that the sense of freedom is a constituent part of humor is doubtless responsible for the "superiority" (and its opposite statement "degradation") theory. The sense of power is pleasurable, but not humorous, for the reasons that (1) the sense of power contains an element of *practical* relationship and (2) the humor stimulus *does not* make us aware of power. Incongruity, descending or otherwise, all disorders of time and space relations in our actions, customs and language, deceived expectation, all disorders of mechanized living movements are only humorous when they excite the sense of freedom. Incongruities are not inherently humorous. They may become excitants of humor by revealing freedom behind human uniformities. It would appear then that the multiplicity of humor theories may be resolved into the freedom theory. The theories hitherto advanced have been more a classification of humorous stimuli than an explanation of humor as a mental process.

A cross section of our adult mental life shows three interrelated aspects: (1) an aspect composed of hereditary factors (unlearned reactions), (2) a well-defined aspect of acquired factors or mechanisms

[10] "Nast, Th., His Period and His Pictures," The Macmillan Company, 1904.

[11] Martin, A. S., "Parody," p. 1.

(learned reactions), composed of what the individual does for himself and what is done for him, and (3) an ill-defined aspect that permeates the other two and in addition occupies a separate existence of its own made up of unmechanized and elementary mental factors. The second aspect will be recognized as intelligence. Professor Royce[12] calls it "docility." It might be termed mechanized mind in that it represents mind reduced to law and habit. Getting on in the world is dependent to a degree on a certain quantum of mechanized mind. Common speech employs such terms as habit, adjustment, education to designate such an equipment. Several processes are involved in its making, such as imitation, learning by "trial and error," by tradition and by "understanding." Of these ways, those that make the most of voluntary attention are the quickest in results and the most extravagant with mental energy; here it is that mental tension reaches its highest pitch. Relief comes in a variety of well-known ways, humor perhaps being the most unique of the lot, from the fact that it accomplishes its purpose with the least expenditure of mental energy and at a time, too, when the individual can ill afford to make sacrifices in the interest of recreation. Considering then the nature of humor as a mental process, and the nature of its stimulus, together with the conditions under which it appears, it seems highly probable that it emerged as a distinctive process from states of inattentive-freedom immediately preceded by states of necessary-attention.

IV. The Functions of Humor

The psychical function of humor is to delicately cut the surface tension of consciousness and disarrange its structure to the end that it may begin again from a new and strengthened base. It permits our mental forces to reform under cover, as it were, while the battle is still on. Then, too, it clarifies the field and reveals the strategic points, or, to change the figure, it pulls off the mask and exposes the real man. In fact, humor is an instrument to aid in the approach to the realities of life—not metaphysical, but *real,* realities!

The physiological function is common knowledge. Its influence on adipose tissue has passed into a proverb, and Kant cherished the belief that laughter had a beneficent effect upon our entire vegetative life. Hecker advocated that it relieved the anæmia of the brain induced by the tickle.

Its biological function in my judgment is far more unique in mental economy than its nature as a process. I have already referred to the unmechanized aspect of mind, a matter more readily believed than easily proved. To adduce adequate evidence of its existence and of the extent of its magnitude and importance over the mechanized and hereditary portions of mind would lead us too far afield. For a better

[12] Royce, Josiah, "Outlines of Psychology," p. 38.

appreciation of the problem, however, a few considerations on the point seem worth while. First, we register our belief in its existence by such expressions as "mind growth," naivété, self-activity, spontaneity, genius, "mental initiative," and by more remote terms like open mind, youthful mind, unprejudiced mind, simple mind. Second, many students of mind tacitly accept it and forthwith attempt its description. This is done by Professor Royce in his "Outlines of Psychology." Professor Shaler expresses his conviction of its existence as follows:

> One of the results of the marvelously swift, absolutely free development of man's spirit is that there has as yet been insufficient time for it to become organized as are the conditions of the body. Working in the instinctive manner in which the lower species do their complicated work through the fore-determined mental processes we term instincts, there are always gauges and standards for the endeavors in the mind as there are in the bodily frame. With us, however, all kinds of thinking are still a hurly burly, a confusion, to which time and culture may possibly bring something like the order it has in the lower life, but which probably is ever to remain in its present uncontrolled shape.[13]

Third, biologists are generally agreed that the human hand, the vocal organs and the cerebral cortex have developed possibilities far beyond present realization. Their possibilities are as yet unknown. The capacity of the cortex appears to be infinite with only a small portion reduced to law and order. If we can so confidently assert unlimited capacity of these physical structures, then any lesser conception of mind is, indeed, an untenable one. It does not yet appear what we shall be, but there is a general agreement that the immediate path of evolution will be spiritual rather than physical. And if spiritual, it can only go on in the free portion of mind, in those parts not yet harnessed to matter and frozen into laws and habits. Of course there is universal agreement that the mind should be mechanized to the extent of the needs of common life, of routine business, of the alphabets of learning and of the elements of culture, but anything beyond these points is inimical not only to individual development, but to racial evolution. While, on the other hand, influences that tend to check mechanization and to incline the mind to grapple with the ideal, the novel, the realities rather than the formalities of life prolong the possibilities of spiritual development. Humor and play are two such influences, with the honors in favor of humor. It stands guard at the dividing line between free and mechanized mind, and like play, it keeps the individual young, projects the best of youth into adult life, sets metes and bounds to "docility" and prevents the mental life of the race from hardening into instinctive and hereditary forms of action. It saves to the world its geniuses and saves the individual from the blighting influence of commercial and utilitarian ideals.

[13] Shaler, N. S., "The Measure of Greatness," *Atlantic Monthly*, December, 1906, p. 751.

A BACTERIOLOGICAL STUDY OF SOILED PAPER MONEY

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IT is generally acknowledged to-day that little progress can be made in sanitation or hygiene without the general cooperation of the public. To obtain this cooperation, it is essential that the people be correctly informed upon all sanitary or hygienic subjects; for should it be found that the demands for this or that improvement are not based upon true scientific facts, how can success be hoped for, when a really essential reform is brought forth?

All will agree that soiled paper money is at least not a thing of beauty, and the unpleasant odors and filth accompanying some bills offend every esthetic sense, and give good foundation for the demand for a more frequent issue or redemption of our currency by the government. Everybody who has traveled abroad will admit that our paper currency is a disgrace when compared to the clean, crisp money to be found in many of the foreign countries, where soiled or worn bills are almost unknown.

In our arguments for clean money, should we include the one which claims that soiled paper money is a frequent medium for the transmission of infectious diseases? The popular opinion to-day is that paper money is very filthy and extremely dangerous to handle, as on it may be found any and all kinds of disease germs known to science. Many people, especially women, have a dread and horror of dirty money and often insist on clean bills when getting change; yet cashiers and bank tellers very seldom think of the filth on the money, and they have no aversion for it. Physicians often seem eager to blame our currency for the spread of disease or the cause of death, especially when it is difficult to find out the true source of infection.

The frequent occurrence of diphtheria and tuberculosis led me to be especially interested in attempts to find *Bacillus diphtheriæ* and the tubercle bacillus on money, and thus prove it to be one medium for the transmission of these diseases. The soiled money used for this study was the dirtiest I could obtain from various sources, such as railroad, trolley and theatre ticket offices, banks, drug stores and individuals in different parts of the state. Some of the bills were much more worn than others, being very soft, cracked and soiled, with frayed edges.

Each bill was thoroughly brushed in twenty-five cubic centimeters of sterile physiological salt solution, the work being carried on under

a glass jar to avoid contamination from the air. In order to estimate the number of bacteria present, 0.5 c.c. of this wash water were diluted with 10 c.c. of physiological salt solution and three series of agar plates were poured, using 0.2, 0.3 and 0.5 c.c. of this dilution. The wash fluid was then measured and centrifugated, the coarse particles of dirt and paper thus thrown down were filtered off and the fluid again centrifugated. With the sediment of bacteria and fine dirt obtained in this manner, I inoculated three bouillon tubes in order to look for streptococci and other forms that might develop. Ten tubes of serum were smeared for the detection of *Bacillus diphtheriæ,* while the rest of the sediment was then carefully injected subcutaneously into a guinea pig. The animals were closely observed for several days so that in case of a fatality an autopsy could be performed immediately after death and the lesions thus more correctly observed. All media used for this experiment were prepared according to the standard method of the American Public Health Association, with a final reaction of + 0.8 (0.8 per cent. acid).

At first I intended to make a study of only twelve bills, since it required a full week to complete the study of each bill; but the appearance in the daily press of accounts of the present agitation for clean money led me to make a total of twenty-four examinations. In twenty of these all the sediment was injected into guinea pigs, in order to allow the development of tuberculosis or septicæmias that might be caused by the bacteria in the sediment; in the other four, the sediment was used for smearing serum plates to detect *Bacillus diphtheriæ.*

It was surprising to find the flora so constant, *Staphylococcus pyogenes albus* being by far the most common form present, with various members of the subtilis group next; *Staphylococcus pyogenes aureus* was found on all bills, but not in large numbers. The following were found on some bills, but always few in number; *Staphylococcus cereus albus,* a streptothrix, *Sarcina lutea,* streptococci and in one instance, *Bacillus xerosis.* Other chromogenic bacteria were frequently found but not identified.

The numbers of bacteria present on the bills ranged from 14,000 up to 586,000, with an average for twenty-one bills of 142,000. There seemed to be no connection between the amount of dirt and the number of bacteria present; the cleanest-looking bill that I used had next to the highest count (405,000), while the bill that looked the dirtiest had but 38,000. When a bill has been in circulation for a short time and has become somewhat cracked, and its peculiar glaze worn off, the bacteria very easily cling to it without the presence of dirt and grease.

All inoculations gave negative results, the time limit being placed at from six to seven weeks. All of the guinea pigs showed more or less local reaction, with swelling of the lymph glands of the groin, but

none gave any indication of even temporary illness. Inoculations of pure cultures of staphylococci, as well as of *Bacillus verosis* (which was at first suspected of being *Bacillus diphtheriæ*) also gave negative results.

From the observations that I have made, it would seem that the bacteria present on paper money are non-virulent and the forms most common are the air forms. Could the loss of virulence be due to drying, the bills having a peculiar dry feeling, no matter how moist the air; or is there some antiseptic action in the ink used for the printing of the bills? I have not taken up the question as to why the bacteria found on money are without virulence, but have confined this study to a careful search for pathogenic forms that might be present on the bills.

The literature on this subject is exceedingly scanty. I have been unable to find any report upon any good scientific work done along this line. Inquiry at the Congressional Library at Washington revealed only four articles—one in Spanish, one in German and two in English, while inquiry among a number of scientific men failed to give me any further assistance with the literature upon the subject of the transmission of infectious diseases through paper money.

That the interest in dirty money, or desire for clean money, is not of recent origin is shown in an article by Dr. Otto Müller,[1] which appeared in 1879. He suggests that money is one means of transmitting the infectious diseases, and although it is extremely difficult to prove an actual case, it certainly offers possibilities. He lays particular emphasis upon the pernicious habit of giving coins to children to play with, especially when they are sick; and also the habit of keeping money under bed pillows, or in commodes or closets where linen or food is kept.

Drs. Acosta and Rossi[2] reported in a Havana journal the results of bacteriological examinations of bank notes made by them. They examined two bills that had been in circulation for some time and found them loaded with germs of various kinds and degrees of malignancy. Cultures were made from the scrapings of the notes and these were injected into the peritoneal cavity of rats and guinea-pigs, most of which died within twenty-four hours, the post-mortem examinations showing signs of peritonitis and congestion of the liver and kidneys. They did not identify any of those germs having "various degrees of malignancy." The fact that the animals died within twenty-four hours indicates that death was not due to the action of any one or more pathogenic forms that might have been present, but rather to the great numbers of bacteria suddenly thrown into the peritoneal cavity.

[1] "Das Geld, ein Krankheitsvermittler," *Monatsblatt f. Öffentliche Gesundheitspflege*, 1879, No. 2, p. 173.

[2] *Medical Record*, August 27, 1892.

Fifteen years ago Dr. J. C. Graham,[3] of Columbus, Ohio, carried on a study of soiled paper money, to furnish data to be used as the basis of a bill placed before Congress for a more frequent redemption of damaged paper currency. He examined fourteen bills, simply shaking them in 50 c.c. of distilled water and adding portions (0.1 c.c.) of this wash fluid to gelatin, for plating.

Agar was used twice, with resulting growth only once; but the author presumes that not all microbes present developed, since many pathogenic forms, especially *Bacillus diphtheriæ* and the tubercle bacillus, will not grow at a temperature much below that of the body, or on the media used. He was able to recognize only *Bacillus subtilis.* To determine the pathogenic characteristics, only two inoculations were made; a twenty-four hour bouillon culture of an unknown bacillus was injected subcutaneously, into a full-grown rabbit, with negative results, excepting a slight rise of temperature. For the second inoculation, the wash fluid from a bill was placed in the incubator for forty-eight hours, and fifteen minims of this were injected into the peritoneal cavity of a rabbit, with negative results. He usually found only two or three species, but in one case claimed to have found five; three bacilli, one of them a spore form, an ordinary micrococcus and a diplococcus. One bill he estimated to have the enormous number of 901,320,000 bacteria upon it. He sums up his article by saying that "Money may be a source of danger by transmitting diseases."

Personally, I can not see that the object of Graham's study was accomplished, for no data were given which could support a bill for a more frequent redemption of our paper currency. The author himself saw the faults of his experiments when he presumed that not all bacteria present developed, especially since the ones in which he was most interested, the pathogenic forms, particularly, *Bacillus diphtheriæ* and the tubercle bacillus, would not grow at a temperature much below that of the body or on the media used; yet he did not attempt to overcome these faults.

In *Revista Medica de Bogota* of July, 1904,[4] there is an article on "The Spread of Infectious Diseases by Paper Money." The author (his name was not given) suggests that the rapid increase of leprosy, in a certain locality during the past three years, may be due to the money in circulation, and he suggests a special currency for lepers. A bacteriological study was made by macerating some bills (twenty) in sterile, distilled water and allowing the wash to stand two or three days in a cylinder. The sediment was pipetted off and smears of it examined. The only germ identified was *Bacillus subtilis,* though

[3] "A Bacteriological Study of Soiled Paper Money," Columbus (O.) *Medical Journal,* Vol. XI., 1892–93, p. 391.

[4] "Del Contagio par el papel moneda," *Revista Medica de Bogota,* Julis, 1904, No. 291, p. 355.

three or four other species were observed. No animal inoculations were made.

Writing on "Money as a Carrier of Infection,"[5] in 1895, C. I. Wendt says: "A thoughtful man and careful student will want some positive information on this subject." He reports upon the experiments of Professor Bolton, on coins, showing that when a coin is placed in the center of a sterile Petri dish, and agar which has been inoculated with pathogenic organisms is poured over it, the medium immediately surrounding the coin reveals no growth, but remains sterile, due to the slight solution of copper, as shown by the potassium ferrocyanide reaction. These experiments should prove of some interest and value by setting at rest any fears which might have been entertained as to the power of coins to act as carriers of disease germs, and by reason of grease and dirt on them, to allow of bacterial growth.

Thus we see that this subject has received no truly scientific study, and those investigations that have been made show little or no merit. Of the various forms of bacteria found upon the dirty bills only *Bacillus subtilis* was identified, and no trace of any pathogenic forms could be found, through either cultures or animal experiments. Inoculations were made in only a few cases, and these all proved negative. In the study upon coins no attempt was made to find what forms of bacteria are common on them, and the results given above do not show coins to be incapable of carrying disease germs, but merely indicate that coins placed in certain media yield enough copper for solution to prevent the growth of bacteria. Coins, as we handle them, do not usually have moisture upon them, and the dry alloy has no antiseptic action; so we should expect to find some bacteria upon coins, as on the bills.

My attention was first called to the present agitation for clean money by articles appearing in the New Haven *Register* and other papers, some weeks after the beginning of this study. Reference was made to "Clean Money Morrison," whom I found on inquiry to be A. Cressy Morrison, of New York, and the origin of all the articles in the daily press and magazines of the country, to be his pamphlet "Clean Money—Can We Have It? If Not, Why?" Inquiring of Mr. Morrison for reference to any work that he might have done along this line, I was referred to an enclosed copy of his pamphlet and circular letter. This pamphlet was "offered to a carefully selected list of 1,000 of the leading newspapers and magazines of the country, . . . and, with a view to the great value of simultaneous publication, a date of release was placed upon the article, . . . it being presented for editorial comment, judgment and criticism, with the hope that all or part of it be printed."

[5] Hahnemannian Institute, Philadelphia, Vol. II., No. 4, p. 4, February, 1895.

Further quotation from this circular letter aptly describes this recent agitation: "There has been much talk on the subject, but no 'do,'" for Mr. Morrison gives no experimental evidence as a basis for this agitation, but says "the statistics regarding germs and microbes found on coins and bills are from one of the most eminent chemists of New York," who, at the instance of Mr. Morrison, made an especial investigation and found that money is one of the most effective ways by which contagious diseases are disseminated, especially loathsome diseases and "the white man's plague."

The statistics, as given, are from the Research Laboratory of the Board of Health of New York; pennies averaged 26 living bacteria each; dimes, 40; moderately clean bills, 2,250, and dirty bills, 73,000 living bacteria each. In order to have these statistics at first hand, I wrote to Dr. Park, of the Research Laboratory, who informed me that the only study made upon bacteria on money, in his laboratory, was completed some years ago. He also said: "We found paper money to be similar to other paper and rags and capable of carrying living tubercle and diphtheria bacilli for some days or longer. We have never found any evidence whatever of the actual transfer of disease through money."

Mr. Morrison outlines clearly his plan for clean sanitary bills and coins: (1) a much larger issue by the government of bills of small denominations, so that there shall be plenty of new money to redeem the old; (2) free registry of all bills sent to the treasurer of the United States for redemption; (3) the establishment in all states of central government stations to which money may be sent by all banks to be cleansed and polished; (4) the antiseptic cleansing by all banks, stores and corporations, of all coins and bills passing through them; and last, that every individual cleanse and disinfect all money which he receives.

I certainly agree with Mr. Morrison that the government should issue enough new bills of small denominations to replace the old, and that it would be a good plan to allow the people to cooperate in the redeeming of the old bills by making the registry of all bills sent to the treasurer for redemption, free. As for the establishment in all states of government stations for cleansing money, would the expense involved be justified, when we consider that not a single case is on record where an infectious disease has been transmitted through soiled money? Is there any method known whereby we can sterilize a stack of tightly bound bills; or will each bill be sterilized separately, perhaps by being spread on a continuous belt passing through a disinfecting solution? And would not the process of sterilization greatly diminish the (non-bacterial) "life" of a bill?

When one bank official of New Haven was informed about the suggestion that banks, stores and corporations should sterilize all money

that passed through them, he asked, "What good would it accomplish to sterilize the same bill two or three times a week? It is surprising how frequently a bill returns to the bank. It is given to one depositor, who uses it for change; soon another depositor obtains it through trade, and when the next deposit is made the bill may again find itself within the same bank."

With a more frequent redemption of soiled money, all these suggestions for such cleanliness and the formation of clean money-clubs may be avoided, and particularly if we learn to keep our fingers away from our mouths both while and after counting money.

Very few people realize the expense and work involved in the redemption of soiled money. Many banks to-day go to great expense and trouble in redeeming soiled and worn bills in order to have crisp, new ones on hand when the demand is made for them. Bankers and business men do not prefer these crisp, new bills, for they can not be counted with as much speed and accuracy as those that have been in circulation for some time. Some banks deposit all their soiled and worn bills with another bank, and thus avoid the expense involved in redeeming them.

All money for redemption must be sorted, so that all bills of one denomination are together; and each denomination must have the various species sorted, such as gold and silver certificates, United States and "coin" notes, etc., while national bank notes must be kept separately. Each package must be labeled with its face value and the words "currency for redemption." National banks pay the express charges on their notes one way, while on all other currency the sender pays the charges both ways. The expense involved is not merely the time taken for sorting the bills or the express rate of forty cents per $1,000, but also the loss of interest and use of the bills while in transit.

During the past six months a series of diseases and deaths have been recorded as being caused by the handling of filthy money. The stimulus for such an increase in the reports of these diseases can easily be traced to abstracts of Morrison's pamphlet appearing in the newspapers and magazines. In the New York *Evening World*, November 8, 1907, there was a report of the death of Edward H. Hall, from "myxœdema," caused by moistening his thumbs on his lips when counting money. Since myxœdema is not considered an infectious disease, this case has no value. The Bridgeport *Standard* was quoted in a local paper on February 25, 1908, concerning the death of John M. Hopkirk, manager of the Mills Hotel No. 2, in New York, who died from scarlatina, contracted, his physicians believe, through the handling of the dirty bills coming from the slums of the city. Personal contact with these poor people who have little or no medical attention and among whom disease often appears in mild and unrecognized forms,

seems to have been overlooked as the most probable means of transmission in this case.

"Germs on Money, Harmless—Dr. Doty rejects a popular theory as to source of infection" says the New York *Times* of February 23, 1908. Dr. A. H. Doty is the health officer of the port, New York. I inquired of him whether he had been correctly quoted in that article and he replied that it practically expressed his views; in fact, he gave me a detailed account of his views which were given in his original article appearing in the New York *Tribune* on November 11, 1907, under the headlines, "No Disease on Money—Foolish to Consider It as a Medium of Transmission." Dr. Doty writes: "This heading may be a little misleading as I do not say that it is impossible for money to act as a medium of infection, but that if it does occur, it is only in rare instances, and this question must be settled principally by practical experience."

The United States treasurer, who has given this subject long and careful consideration, is emphatic in his statement that there is not the slightest evidence to show that the employees in his department contract infectious diseases any oftener than others who are not in this line of work. This also applies to bank tellers and clerks. Peculiarly enough, those who claim that they have made a careful study of this question do not seem to understand that persons whose vocation involves the constant handling of money are susceptible to the same outside influences or exposure that others are, and are therefore equally liable to contract infectious diseases in the ordinary way, and that the handling of money does not render them immune to disease.

Dr. Park's statement that he found "paper money to be similar to other paper and rags, and capable of carrying living tubercle and diphtheria bacilli for some days or longer," does not mean that money is a frequent medium for the transmission of infectious diseases.

Dr. Doty has for years made a study of infectious diseases, and especially the medium of their transmission. He has collected reliable statistics from paper manufacturers in this country, and has made a personal investigation of the rag depots of Alexandria, Egypt; yet no evidence has ever been found to show that these rag pickers are more subject to infectious diseases than those not connected with the work. "It is fortunate," he says, "that money constitutes such an unimportant factor in the transmission of disease, as nothing could be more farcical, from a sanitary point of view, than an attempt to disinfect it, although this has been seriously proposed. It is important that those who have given this subject careful investigation should aid in the education of the public, in order that they may have a proper understanding of the matter and not be alarmed by sensational literature on the subject."

I do not claim that my study of twenty-four bills proves con-

clusively that money is not a means for the transmission of infectious diseases, but I do think that the absence of virulent disease germs shows that soiled money is at least not a common means of transmission of disease. In order to obtain any conclusive evidence on this point it would be necessary to make a careful study of hundreds or even a thousand bills from hospitals and private sick rooms, drug stores and various other sources.

Emphasis must be given to the animal inoculations carried out in connection with this study, for in a study of this kind they are much more important than the culture experiments, when we consider the susceptibility of guinea pigs to many of the infectious diseases, especially tuberculosis and diphtheria. There may develop within the animal body other forms which would not be detected in a study of the cultures or smears.

It is no surprise that the theoretical does not agree with the practical side of the subject under discussion. This is often the case, especially when the subject is one which concerns the general public, the majority of whom readily agrees with any one who says that dirty money is a certain means of transmission of infectious diseases. Why shouldn't this be so, when we think of the dirt and odors that accompany some of our paper currency? The bills have been in contact with many hands, not necessarily infected ones, but some that have at least been in contact with sores or sputum. Certainly a black picture could be painted and the possibilities made to appear enormous; yet another view is clearly set forth by a bank teller who said: "If one stops to think, money can't be a very common means of transmission, for if it were there wouldn't be so many of us alive to-day; the escape from sure death of those whose duty calls for the constant handling of money, is certainly not merely due to chance."

One conclusion that may be drawn, after a careful study of the subject, is that "money constitutes an unimportant factor in the transmission of disease." We want and certainly need a more frequent redemption of our soiled and worn bills, yet the facts and evidences at hand do not justify us in alarming the public needlessly by rash statements concerning our currency. Admitting the possibility that money may act as a medium of transmission, certainly the failure of any virulent disease germs to manifest themselves in the foregoing experiments will allow us to feel a bit easier in regard to dirty money.

FACTS CONCERNING MILK

By A. E. P. ROCKWELL, M.D.

WORCESTER, MASS.

THE cow is the foster mother of our civilization. And fortunate are we in being able to secure the services of this humble animal in our endeavors to arrest the most important cause of race suicide. For our greatest menace in this direction resides in the fact that an alarming proportion of infants must be vicariously nourished at some period of their development by the cow.

Owing, on the one hand, to that sinister development of our industrial system which compels many women to engage in competitive factory labor, and the invasion by women of almost every field of human activity; and, on the other hand, to the unwholesome influences surrounding those immersed in the fatuitous struggle for social supremacy, we find that each year rewards us with a larger percentage of women who are unable to nurse their children.

One way, then, of registering the progress of civilization is in noting the constantly increasing proportion of infants in the rearing of which artificial feeding plays an important part.

It may, with some truth, be urged that owing to the educational influence of mothers' clubs and the like, and the entreaties of physicians, there is among a certain class of women possibly a greater desire to nurse their little ones; but of what avail is this inclination if their previous condition of servitude to a life not in consonance with this result, renders them physically unable to perform this important function? And it must be noted that this physical unfitness is not necessarily due to a failure on the part of the glands to which the duty of supplying lacteal fluid is assigned.

Many mothers are able to furnish for their children a fluid, but it can scarcely be designated as milk, owing to the fact that the blighting effects of unhappy or unwholesome emotions so common among wage earners, the over-worked housewife and the social aspirant render the milk entirely unfit for food.

To-day we live under high-pressure conditions, with accompanying wide fluctuations in emotional experiences, developing resultant temperamental effects notably prejudicial to the manufacture of a wholesome milk in the nursing mother. The chemistry of the emotions plays an important part in the welfare of the child.

It has been shown that as the result of vexation, disappointment, grief and kindred emotions certain highly organized chemical products are elaborated within the economy which find their way into the blood stream and thus into the mother's milk, rendering it more or less harmful to the infant receiving it. Hence, if it were possible during the period of lactation to transmute all women representative of the classes above indicated into wholesome, phlegmatic German peasant mothers, our milk problem in its multiform aspects would be wonderfully simplified. The present social order not only makes impossible such conditions, but we must calmly face a future in which maternal inefficiency in this regard will be even accentuated.

Some of us believe the solution of the vexed question of the overpopulation of the earth is resident in this problem of artificial feeding, particularly as certain statistical relationships seem to be springing up between the notorious modern birth rate and inefficient maternal nourishment, and we are learning that unsatisfactory as is artificial feeding at its best and perilous as it may become, it is, in any event, much more likely to be productive of good results than the attempt to nourish an infant on the milk of the mother physically, occupationally and temperamentally unfit.

Again, our apprehension must not be transformed into despair, for unremitting educational endeavors will ultimately insure a better milk supply and greater intelligence in its use. So while milk is regarded the most perfect of all foods for the young or old, in sickness or in health, the milk problem is virtually the children's problem, for cows' milk, modified in accordance with the requirements of each particular case, has been found to be the only practical method by which nature's plans for early nourishment of the human infant may be successfully imitated. Any attempt at the solution of this question, therefore, which fails to emphasize our guardianship of the interests of the child would be calamitous.

Surgeon-General Walter Wyman of the Public Health Service says:

The steady decrease in general mortality does not apply to infants. It is recognized that gastro-intestinal disease is the largest single factor determining infant mortality. This enormous loss of potential wealth is of grave concern to the state and worthy of most careful consideration.

Further he says:

Dr. Eager gives figures to prove that the high infant mortality may be attributed almost entirely to impure milk.

Inasmuch as one child in every twenty in our large centers of population dies before five years of age of maladies traceable directly or indirectly to contaminated cows' milk, it may be well to outline very briefly some of the properties of this indispensable food and a few of the problems associated with its production and supply.

Milk is at once the most important and the most perishable of all food products. Fresh milk is the most perfect mechanical emulsion known and contains roughly proteids (albuminoid substances equivalent in nature to the white of the egg) fat, in the form of minute globules which are later represented as cream, milk sugar, certain mineral salts and water. There is more or less fluctuation in the proportion in which these substances appear in all milks, particularly the milk of cows, owing chiefly to the development (in some instances covering periods of many hundred years) of certain breeds of cattle, possessing, among other qualities, certain characteristics as milk producers. I say chiefly to the development of breeds, because repeated experiments with various breeds have shown that it is not possible to alter materially the proportion in which the various constituents of milk appear in the milk of any given cow by any process of feeding yet discovered.

Improved methods of feeding increase the total *quantity* of the output, but not materially the quality, and any attempt to force by feeding an increase in the percentage of any one of the ingredients in the milk (particularly the fat content) may increase slightly for a short time such content, but it soon drops to the normal for each cow, and the experimenter has run the risk of ruining the animal experimented upon.

A popular fallacy prevails which enshrines in the minds of the uninformed the belief that milk having a large percentage of fat is rich milk, and hence, the best milk. Milk rich in fat and the best milk from both a physical and a chemical view are not synonymous terms, either as a matter of domestic economy or as applied to its use for infants. While all good milk must possess fat, the consideration of the amount thereof from a nutritive standpoint is second to that of the proteid content except in a certain few selected cases, which rarely include babies or young children.

Dr. J. A. Gilbert, writing in *The Medical Record* (New York), takes the view that this devotion to "rich" milk has no logical basis. In our earnest search after a fat milk, he says, we have probably gone too far. To quote from an editorial in *The Hospital* (London) which notes Dr. Gilbert's opinion appreciatively:

> **The milk which is richest in cream is not, therefore, the most nutritious, for the very simple reason that a rich milk is less easily digested and absorbed than a milk in which the fat percentage is low. As far as its other constituents are concerned, a milk poor in fat is as valuable a food as a milk rich in fat.**

Owing, then, to ignorance or personal interest, recent discussion of the milk problem throughout the land has revolved around the percentage of fat in milk and undue prominence has been given this phase of the question.

Protein is the most important nutritive content in all milks, and

is the one toward which breeding efforts and the attention of the consumer should be directed. As protein, the tissue former, is the most valuable constituent of milk, it follows that an endeavor to insure a high percentage of this indispensable food element should be the aim of any legislative enactments having in view the establishment of milk standards (of which we hear so much in this day) and not the maintenance nor increase of the fat content. And when it is understood, moreover, that as the fat content of milk increases, the tendency probably is toward the decrease of the proteid content, the folly of this course becomes patent.

Legislative measures referable to the production, transportation, sale and consumption of milk have had and will continue to have a most important, direct and indirect influence upon the character of the herds supplying the milk to the several communities in which such legislation is operative.

As laws represent the will of the majority and as the majority in this instance are the consumers, it behooves us, as such, to understand what is desirable in the matter of milk and then through educational effort work toward the attainment of it.

A word here regarding the leading characteristics of breeds of cattle may not be amiss. All cattle may be roughly divided into three general classes according to the purpose for which they are designed—the beef breeds, the general purpose breeds and the dairy breeds, with the last of which only we are concerned. The dairy breeds are again roughly divided into two great classes.

First, those who give large quantities of milk containing a normal proportion of fat divided into small globules. Of this type the Holsteins and Ayrshires are examples.

Second, those in whose milk a large percentage of fat is found in the form of large globules but who in general are somewhat delicate and comparatively small milkers.

Jerseys and Guernseys are typical of this class.

Before the introduction and general use of the separator, a device which separates the cream by centrifugal force from the fresh milk, the dairy breeds represented in the second class were in great demand, because with their milk the cream rose quickly to the surface on standing and was easily skimmed. The skimmed milk, however, of these breeds has the bluish color, familiar to all housewives, and is possessed of small nutritive value. Excessive fat production having been developed at the expense of the food value contained in the whole milk. Moreover, the fat globules are large, being about three times the size of those of the breeds representative of the first class, and hence much more difficult of digestion by children and most invalids.

In this connection, Chas. W. Townsend, M.D., of the Boston Floating Hospital, says:

> The *quality* of the fat of Jersey and Guernsey milk, aside from its *quantity*, is in some infants a cause of digestive disturbance; I have many times seen babies gain but slowly and show fatty stools on Jersey milk modifications, even when the percentage of fat was low, while the same babies gained rapidly and digested well the modifications having the same amount of fat, made with the milk of Ayrshire, Holstein or common red cows.

Since centrifugalization was introduced much more attention has been given to breeds giving more rational milk, for the separator removes as easily and at the same cost the fat from a low as a high percentage milk. Hence, the effort as indicated has been to develop breeds which would produce skimmed milk which was nutritious and regarding the manifold virtues of which as a food we need not enter into here.

So highly developed are some of these breeds of the first class that it is worthy of note that many individuals are to be found that will give their weight of milk each month and total butter production for the year, equivalent to one half their weight.

Hence, we find in breeds representing the first class, namely, the Holsteins and the Ayrshires, the qualities particularly desirable in the family cow, inasmuch as their milk is best for infants, and furnishes a perfectly balanced ration alike for older children and adults.

Again, important as are the chemical analysis of milk and urgent as is the necessity of its being delivered fresh and uncontaminated, the question of the vigorous health and temperament of the individual cow is quite as vital.

Let us then again consider the relative merits of the two classes of dairy cows as heretofore indicated, in relation to their claim for excellence in this indispensable particular. Mention will be made only of the leading breed in each class in order to emphasize the illustration.

It is a well-known fact that the Jerseys, as bred and cared for in this country, have a highly irritable nervous temperament, and are more difficult to feed, rear and manage than any other breed.

The Holsteins, on the contrary, are a large, healthy breed of placid temperament, great constitutional vigor, enormous digestive and producing capacity, comparatively resistant to disease, and flourish to a high degree in our trying climate. The same qualities which commend the wet nurse in the performance of the function which the child's natural mother is unable to perform, are those which should commend to the community the cow which now, more than ever, sustains to the infant population the relationship above indicated.

Common knowledge independent of scientific observation sustains the fact that a nurse with poor or delicate digestion, sensitively and

highly organized, irritable nervous temperament, doubtful vital resource or resistance, is entirely unsuitable to rear a child. The same is true of the cow, and her individual adaptability must now be subjected to the same scrutiny. Many an infant has had its life imperiled or has been lost owing to its receiving its nourishment from a nurse who has suffered from disappointment, anger, hysteria, indigestion, lack of exercise or the like.

Much of our artificially fed infant mortality is due, directly or indirectly, to the presence in cows' milk of similar poisons generated in nature's wonderful laboratory and as defiant of test-tube analysis as are those other qualities in the milk of strong, hardy cows which, for want of better names, we designate as vital energy or vital force.

Speaking of vitalizing power in the milk of certain cows as compared with others, Professor Carlisle, of the Wisconsin Experiment Station, says:

> The point I wish to make here is that there is such a thing as vitality in milk, and that it is of equal if not greater importance than is chemical composition especially for the milk supply of cities. And there can be no question but that the vitality of the milk is closely associated with the vitality of the animal producing it.

The effect, then, of laws requiring a high percentage of fat will be to put a ban upon the most sturdy, healthy, normal, productive and useful breed of cows the world has ever known, for they are to be found in every country of the globe and probably produce more milk and by-products than all other breeds combined. It will encourage the sale of the milk product of a breed which is neither hardy nor vigorous; which is probably more susceptible to tuberculosis and other diseases, owing partly to the fact that their delicate constitution requires housing more months of the year than any other breed; a breed giving a milk not only entirely unsuited to the purposes of artificial feeding of infants, but possessing excessive fat and other deleterious properties to such a degree that many of the cows of this breed are unable to rear their own calves; a breed originating in a salubrious climate, reared with the tenderest care, and brought to this inclement land to be exposed to conditions unnatural to them or their ancestors and therefore resulting in a milk product which, according to modern standards, is undesirable in many ways.

Many state institutions throughout our commonwealths maintain herds of Holsteins, some of which are among the finest in the land, in the confident belief that it would be impossible to supply such an abundant quantity of highly nourishing milk through the medium of any other breed.

Thomas Morgan Rotch, M.D., the distinguished authority on the diseases of children, speaks as follows regarding the value of the milk of this particular breed:

For instance, good Holstein milk is at times not salable on account of its total solids not coming within the limits of the law (Massachusetts State Standard). The law demands during winter 3.70 per cent. fat and 13 per cent. solids, while in the summer 3 per cent. fat and 12 per cent. solids. As we all know, the Holstein milk, unless the cows are especially fed, falls below this standard. Now, from a medical point of view the Holstein milk is exactly what we find best for infant feeding and it is an extremely good milk for any one to drink.

The immense number of infants, however, who live entirely upon milk should be taken into consideration in this question, and I believe that the people should be allowed to buy this milk just as they should be allowed to buy a milk modified to suit a special infant who is being taken care of.

Too much can not be said or done to encourage the production and consumption of a food product which possesses nutritive elements of the right kind in the proper proportion, and nourishing qualities of such high value—a product which is essential to the proper development of the child, upon the future health of which the state becomes dependent for its prosperity, a product which has made healthy, contented and prosperous the nation, which for two thousand years has enjoyed its benefits.

As we have seen, no cow can obey the mandate of a legislature, no matter what liberty she may be allowed to exercise in the choice of her food. Some protection against adulteration and other forms of fraud in these selfish and greedy commercial days is necessary, but a standard based upon the total fat and total solids not fat, in milk, particularly when that fat percentage is placed so high that none of our most useful and healthful breeds can produce herd milk in compliance with it, simply defeats the object for which it was designed.

For example, the milk test at the St. Louis Exposition was probably the most scientifically conducted and most illuminating in results ever made in this or any other country.

Among others the following groups competed in the tests: twenty-five Jerseys, five Brown Swiss, fifteen Holsteins and twenty-five Short Horns, not one of which produced milk up to the legal standard established by some states, and yet these cattle had been selected and fitted for an international exhibition, and were fed, groomed and tutored by experts in the art of milk production. Some of the very animals, valued perhaps at several thousand dollars, are producing milk in several different commonwealths to-day, which if sampled by the state inspector could put its owner in jail for violation of the law. Moreover, when we understand that the relative percentage of fat and solids not fat, in milk, varies in each cow with the period of lactation, time of day when the sample is taken, with the weather and seasons, the physical condition, and many other contingencies, and when we realize that two quarts from the same cow can differ; also two quarts from

the same milk pail and mixing tank, some of the difficulties in establishing a just, arbitrary standard may be appreciated.

It is difficult to induce the public to realize that refined methods of analysis, the more careful attention to breeds and breeding, the great difficulty of supplying from considerable distances, the ever-increasing urban demand, the introduction of centrifugalization and other important considerations have entirely changed the complexion of the milk problem within a very recent period.

Many of us do not realize that much of the milk consumed in our large cities is taken from herds kept as far as 300 miles or more from the consumer, and when it is delivered to him is frequently forty-eight hours old. The problems surrounding the transportation of such milk in the summer season may be in part appreciated when we know that the presence of 5,000 bacteria to the cubic centimeter is considered a reasonably low count and that under favorable conditions this number is capable of doubling by geometrical progression every half hour.

Samples of commercial milk taken in New York city recently showed 35,200,000 bacteria to the cubic centimeter; London, 31,888,000; Washington, 22,134,000. That seventy-eight typhoid germs in one cubic centimeter of milk increased in seven days to 440,000,000 furnishes an illustration of the possibilities in this direction, and when one realizes that one cubic centimeter is equivalent to about sixteen drops, some idea may be gained of the bacterial population of much of the milk we drink.

Milk removed properly from a perfectly healthy cow, and kept in receptacles previously sterilized, contains practically no bacteria, and may at a low temperature be preserved for days without material change. When, however, these precautions are not observed the results are as above indicated. Not all these germs are harmful, but many varieties are exceptionally prejudicial to the health of children. Each of 500 epidemics recently investigated, including typhoid fever, scarlet fever and diphtheria were found to be caused by contaminated milk. That 11 per cent. of milk samples examined from Washington contained tuberculosis germs need not be considered as exceptional and can be verified by the examination of data of a similar nature from other cities. And when we understand that the milk supply of New York city, for example, is derived from the product of 35,000 farms and shipped from 700 creameries located in six different states, it is easy to appreciate some of the difficulties surrounding the protection of the community from the sources of infection contained in milk.

In recent years the prominence given to tubercular disease in cattle, with the consequent appearance of the tuberculosis germ in the milk of such cattle, has entirely overshadowed the importance of certain other diseases in cows, likewise accompanied by the presence in the milk of cows so suffering of enormous numbers of bacteria character-

istic of such diseases. I refer particularly to the disease known as "Mastitis," an inflammation of the udder accompanied by the presence of certain bacteria largely of the pus-forming type which are discharged with the milk in enormous numbers.

While possibly a smaller number of cows suffer from this disease than from tuberculosis (and herein probably lies the reason why this important source of infantile mortality has been overlooked), many cows not only suffer from repeated acute attacks in which far greater numbers of these bacteria are eliminated with the milk than tubercular germs in pulmonary tuberculosis or even tuberculosis of the udder, but not a few suffer from a more or less intractable, chronic type of this malady which renders them a never-failing fountain of mischief.

Probably the major portion of the grave intestinal disturbances of children are due directly or indirectly to the presence in milk of the bacteria characteristic of this disease and the ptomains, toxins and kindred substances which always accompany certain types of bacteria activity. And notably is this true of milk, for it is a most excellent example of what is known technically as a culture medium, meaning a substance favoring in a high degree bacteria development and growth. Some one says: "Yes, while this is all very bad we can protect ourselves by pasteurizing or sterilizing our milk." While either of these processes properly carried out will destroy the germs or for a few hours prevent their activity they can not destroy the ptomains or like highly organized poisons already present, and as dangerous to human life as they are crafty in eluding chemical analysis.

Pasteurization, then, the proper execution of which requires much skill and training, removes from contaminated milk but part of the danger while its palatability has been impaired and its nutritive properties somewhat altered, and we are obliged to drink the carcass of millions of bacteria still suspended in it. The tendency, moreover, of pasteurization is to put a premium upon dirt, which gains entrance to milk chiefly through careless methods in milking and caring for milk after it leaves the cow which carries with it a great multitude of bacteria and is the most important source of bacteria contamination of milk.

It has been computed that the people of the City of Berlin drink in one year many hundred pounds of cow-barn filth suspended in milk.

Milk so produced as to be free from dirt (unhappily not the milk of commerce) may be considered also comparatively free from bacterial growth.

Pure milk, fresh milk produced free from germ and dirt contamination in the stable and during handling and transportation, is the birthright of our children, is what we all desire and is the goal toward which the various boards of health, cattle inspection bureaus and

similar agencies of our commonwealths are striving for against heavy odds.

Two great obstacles stand in the path:

1. The difficulty, even under repeated inspection of premises on which milk is produced (inspection in some instances emanating from four or five separate sources) to induce the producer to adopt cleanly methods of production.

2. The increased cost to the consumer of milk so produced, a cost which the poor man can not and the well-to-do are disinclined to meet. For in many of our states it is doubtful if such milk as we would all like to use could be delivered at our doors, under the conditions of increased cost which prevails to-day, at 15 cents a quart and allow the farmer and the retailer each a reasonable profit thereon; for in farming, as in other lines of business, cost of production must include interest on investment, taxes, depreciation, labor, raw material (hay, grain and the like) insurance, and similar charges.

But what remedy may we hope to apply to extricate ourselves from the present dilemma? Rather than fritter away the money and energies of the various states in trying to maintain standards for fat and solids not fat which are not only impossible of attainment, but a constant menace to the farmer and a prolific source of irritation and discontent to all concerned in the milk industry. Let us now concentrate our efforts upon an endeavor to insure a pure milk supply for the children. This can best be done by taking the machinery of the state boards of health and kindred agencies now employed in cattle and milk inspections and direct their activities along the lines of a certified milk supply which has been applied with measurable success in connection with certain cities—the plan being to enlarge the scope of the work, as at present conducted, so as to include all the dairies supplying the commonwealth with milk whether situated within or without the state.

Certified milk means that a dairy has been properly inspected by trained and competent officials who give to the owner thereof a certificate allowing him to place upon the containers of milk leaving his farm (for a certain period until a subsequent inspection is made) a label indicating that the milk is absolutely clean and produced under sanitary conditions by a healthy herd.

This plan minimizes the technicalities and red tape ordinarily attending work of this nature and promises to vouchsafe to us and our children a milk supply in character consonant with the demands of the civilization in which we live, but it can not be secured unless a majority of us demand it and are willing to pay for the additional expense which it entails.

SHALL OUR FOREST WEALTH BE DESTROYED?

By THOMAS ELMER WILL
SECRETARY OF THE AMERICAN FORESTRY ASSOCIATION

IN the sunny southland, stretching from Pennsylvania in the northeast to Alabama in the southwest, are the Southern Appalachian Mountains. These constitute not a single ridge or chain, but a zone or belt composed of numerous parallel ridges, as the Alleghenies, Blue Ridge, Black, Unakas, Smoky, etc. Connecting these ridges, often, are cross ridges equaling in cases and even exceeding the longitudinal ranges.

Surmounting these ranges at many points are lofty peaks. Of these the chief, Mt. Mitchell, is 6,711 feet high; 46 more, a mile or more apart, with 41 miles of divide, rise to an altitude of 6,000 feet, while 288 others, with 300 miles of divide, reach a height of 5,000 feet above the sea. Among these may be mentioned, in the Blue Ridge, Grandfather Mountain, 5,964 feet, Pinnacle, 5,693 feet and Standing Indian, 5,562 feet high. In the Smoky Mountains, Mount Guyot reaches a height of 6,636 feet, and Clingmans Dome, 6,619 feet.

"Between these groups of mountains and far below them, though still at an elevation of 2,000 feet or more above the sea, are the numerous narrow valleys of this region." Many of them are marked by great fertility and beauty.

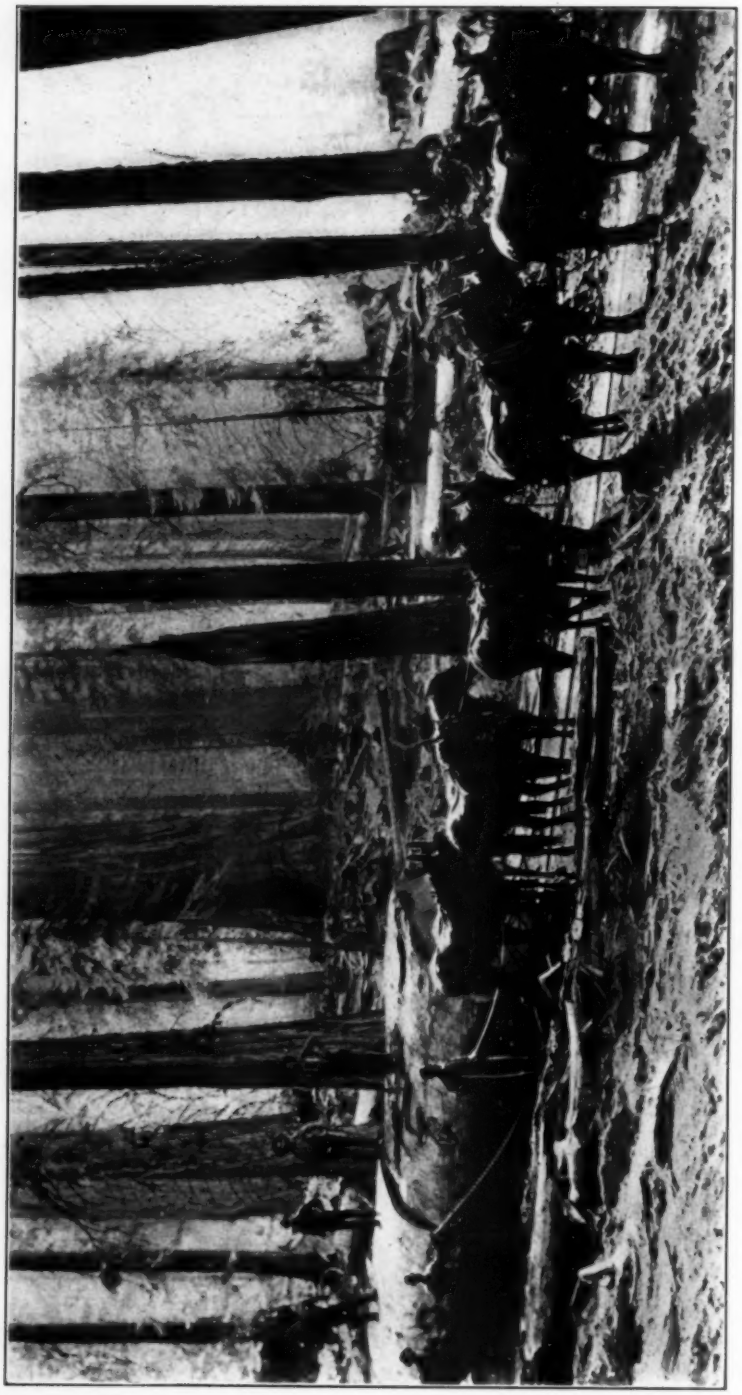
Save on the highest peaks, or on the slopes where man has interfered, these mountains are clad with a magnificent growth of forest. Near the bases are found oaks, hickories, maples, chestnuts and tulip poplars, suggesting in size the great trees of the Pacific coast. Higher, one passes through forests of great hemlocks, chestnut oaks, beeches and birches, and, still higher, through groves of spruce and balsam. Near the tops, the balsams become dwarfed and are succeeded, largely, by clusters of rhododendron and patches of grass fringed with flowers.

In this region, ranging from 60 inches in Georgia to 71 inches in North Carolina, occurs the heaviest annual rainfall in the United States, save on the Pacific coast. The water thus precipitated finds its way to the sea, east, west, southeast or southwest, through practically all the important rivers of the south. The Southern Appalachians thus constitute the watershed for, practically, the entire region below the Potomac and Ohio and east of the Mississippi. The descent of the water from the mountainsides is marked by some of the most beautiful cascades and waterfalls that ever gladdened human sight. Among

PLANTING PINE SEEDS, SAN GABRIEL NATIONAL FOREST, CALIFORNIA.

these may be named the Falls of Elk Creek, near Cranberry, N. C., the Upper Falls of the Whitewater River, the Lower Cullasaja Falls of Macon County, N. C., and the Toccoa Falls of Habersham County, Ga. Thus, with infinite variety of mountain and valley, forest and stream, cascade and waterfall, beetling crag, bold precipice and dizzy gorge, this entire region presents a scene of transcendent natural beauty and sublimity.

As a national park and recreation ground this area has no equal in the United States. Unlike the splendid but remote Yosemite, it is within twenty-four hours' ride of 60,000,000 people. With modern transportation facilities the cities of the east—New York, Boston, Philadelphia, Baltimore, Washington; of the south—Charleston, Atlanta, New Orleans, Nashville, Louisville; of the middle west—Cincinnati, Cleveland, Indianapolis, St. Louis, Kansas City and Chicago—are almost at its doors.



MILLWOOD, CAL. LOGGING A BIG TREE.

Such a recreation ground is a crying national necessity. As a people, we work too much and rest too little. Herbert Spencer, when in America years ago, declared that we had heard enough of "the gospel of work," and that what we most needed was "the gospel of relaxation." Since then the situation has grown worse rather than better. It is the old story of "all work and no play"; and the effects are seen in nervous prostration, insanity and suicide.

Again, from the economic standpoint this area is invaluable. It contains our last remaining, important stand of hard woods. Forest Service statistics, the prices of lumber and all wood products—mounting by leaps and bounds—and common observation unite in testifying that our timber resources are being consumed and wasted in prodigal fashion and at a startling rate. The Southern Appalachian forests, however, the hand of the spoiler has delayed to enter; and, though the supplies, once thought inexhaustible, of New England and the Great Lake regions are practically gone, this area still contains a vast and priceless stock of the choicest timber on the continent.

We have heard of the "new south." It is the industrial south; the south of the railroad, the furnace, the loom and the spindle. From the purely agricultural, this section is rapidly entering upon the manufacturing stage. Irrespective of the question of labor, for such activity it enjoys some special advantages. Its staple, cotton, is near the mill, and its water-power facilities are magnificent.

Like many other things, power is a creature of evolution; first, it manifests through human strength; then, through "the energizing of brutes"; later, through wind and water crudely applied; and then, as the Yankee said, through water "biled," releasing, thus, the titan, steam, at whose feet, it has seemed, the very earth lay prostrate.

But the waning of the steam-engine is already in sight. New powers are appearing on the scene; the next of which, we may well believe, is electricity.

What a coal vein is to the steam-engine, a waterfall is to the dynamo.

As indicated, the Southern Appalachians abound in magnificent falls; from these, electric power can be developed cheaply and in great abundance. With the introduction of means of transmission it now becomes possible, instead of carrying the plant to the power, to bring the power to the plant. The gain is obvious.

The possibilities of electric power as applied to manufacturing in the south may be appreciated when it is known that North Carolina, South Carolina and Georgia alone maintain cotton mills operated by water power which produce annually a product valued at over $60,000,000. "The water power of this southern region already developed or being developed is estimated at 500,000 horse-power. The unde-

RANGERS HAZZARD AND BROWN, OF LEADVILLE NATIONAL FOREST, COLORADO.

veloped water power is probably not less than 1,000,000 horse-power more."[1]

The mighty interests here indicated are bound up with the preservation and perpetuation of the forests upon the Southern Appalachian Mountain slopes. The value of water power is limited by the low water flow. The question is not, How much water is discharged annually? nor even, How great is the average flow per month? but How great is the minimum? Hence constancy and a reasonably large volume are essential.

These are insured by the preservation of the forests, for the forest mulch holds back the water precipitated by rainfall and thaws, and discharges it gradually the year round. If, on the other hand, the mountainsides are stripped of their vegetation and then, by fire and floods, denuded of their soils, the water which, gradually supplied, might have driven the mills, now descends in disastrous floods, only to be followed by long periods of low water.

Agriculture is, of course, largely dependent upon natural irrigation from the rivers fed from these mountains. To it the alternation of flood and drought is as disastrous as to manufacturing by water power. Similarly, the great transportation interest of the south is intimately concerned. Its profits are directly dependent upon tonnage, and tonnage is dependent upon the productiveness of the region served.

What, now, is the situation of the south as respects the conservation of these interests?

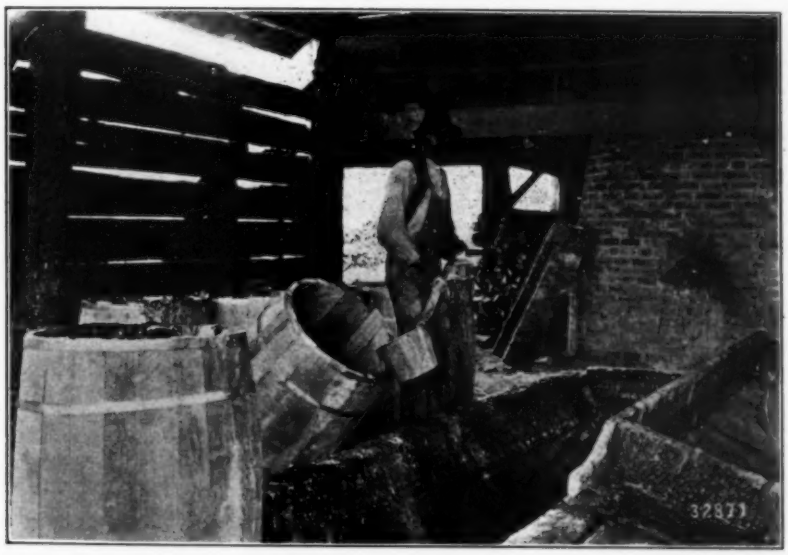
[1] U. S. Senate report No. 2537.

Three foes menace the forests. First is the exploiter of forest lands. Chief among these is the small mountain farmer. In a region never designed for agriculture he endeavors, with primitive appliances and obsolete methods, to grub out for himself a scant subsistence. To do this, he must sacrifice the trees.

Making a mountain farm, however, is quite a different thing from maintaining it as a farm. Under the crude culture practised, a period of from five to twenty years suffices to exhaust the land and send the farmer farther up the slope. Here he repeats the process; and thus, as he ascends, he leaves in his wake a tract of desolation, for the swift-descending rains soon convert these cleared areas into irreclaimable gullies.

Second come the exploiters of the woods themselves. Among these may be mentioned the turpentine man, who, by a crude method of extracting the resin, though a far less hurtful might be employed with greater profit to him, is rapidly despoiling large areas of forest. The tan-bark man, next, strips from the trees their bark, and leaves their unused hulks to cumber the ground. The pulp man clears the ground of all trees—old, young, large and small—and so prevents the forest from renewing itself. Finally, as the bonanza farmer attacks the Dakota wheat-field, the lumberman, with methods long tested and equipment perfected, invades the forests, and the monarchs fall before him like grain before the sickle of the harvester.

Next and most terrible, sometimes from accident, sometimes from design, comes the fire. In the slash and wreckage left by wood-cutters



STILL HAND-DIPPING ROSIN FROM VAT INTO BARRELS. OCILLA, GA.

it rages as in a Chicago or a San Francisco; and in its seething caldron disappears not only the last vestige of wood but the very soil itself.

Last of all follows the rain. This, falling upon denuded slopes, is transformed from a blessing into a curse; for whatever movable thing remains is swept by it down the mountainsides to glut the streams and harbors and insure the overflows which convert the streams of the south into so many Hoang-hos or "rivers of sorrow."

In the face of this process almost every legitimate interest of the south is menaced. Natural beauty disappears like the splendor of the butterfly clutched by the schoolboy. Agriculture, manufacturing, transportation and the industries tangent thereto are doomed to pro-

DINKEY ENGINE AND GEARED LOCOMOTIVE, DOUGLAS SPRUCE DISTRICT. OPERATIONS OF SIMPSON LOGGING CO., MASON CO., WASH.

digious losses and, in cases, to extinction. The whole region involved is threatened.

And the remedy? President Roosevelt, quoting and endorsing Secretary Wilson, has put it tersely: "The preservation of the forests, of the streams, and of the agricutural interests here described can be successfully accomplished only by the purchase and creation of a national forest reserve." A cluster of thinkers, writers and publicists have borne similar testimony.

And why should a national forest reserve prove a remedy?

For this reason. There are in operation in our industrial life to-day two principles. The one is that of private initiative, individual profit and *laissez faire;* the other is that of public ownership, and

administration for the public good. That the first has achieved victories, belted continents, surmounted Alps, tunneled mountains and worked miracles let us concede. Nevertheless, it has its limitations. That this is true, experience, with its insurance investigations, rate bills, meat inspection, pure-food legislation and the like, is daily making clear. In the field of forest administration and exploitation—notably when the forests in question control important river sources—the limits of *laissez faire* were long since, and after fearful public loss, recognized in Europe.

In such a case, the individual initiative principle works directly counter to the public good. Private interest impels the doing of almost all the mischievous things above enumerated: clearing slopes for farm-

THE RUINS OF A BRICK HOUSE DEMOLISHED BY THE FRESHET OF MAY 21, 1901. BAKERSVILLE, MITCHELL CO., N. C.

ing, stripping trees for bark and leaving the trunks to rot, cutting clean for pulp, and felling at once for lumber purposes trees which should be left indefinitely on the ground. Abusing the exploiter is gratuitous, vain, unjust. His "greed," so called, and his disregard for public interests are no greater than those of other men. He is simply following the principle whereby successes have been achieved and fortunes won on every side; but, in so doing, he is, nevertheless, mining and sapping at the very foundations of national well-being.

The second principle, on the other hand, impels the quest not for

THE SHAPE OF THE CLOUDLAND MOUNTAIN, BETWEEN GREEN COVE AND THE HEAD OF BEAR CREEK, SHOWING LAND SLIDES IN PASTURE. These were made in the storm of May 21, 1901, and covered from 100 to 500 square feet. Mitchell Co., Cal.

private profit and individual fortunes, but for the general welfare. It views a question from the standpoint not of the individual, but of the community. It recognizes that the nation which would hold its place in the world struggle and in universal history must husband its natural resources and raise the general level of its average citizenship. Viewing a forest-covered slope, the representative of the private interest principle says: "Here a principality may be won. Come, see and conquer!" But the exponent of the public-interest principle says: "No; your present, petty gain can be reaped only by irremediable public loss. The whole is greater than any of its parts. The public safety is the supreme law. The government stands for all the people. In their interest, therefore, we encircle this area with the ramparts of public protection. To private initiative we say, 'Thus far shalt thou come, but no farther.' For the nation's sake this territory shall be conserved and forever publicly guarded and administered."

The present national forest area of the United States now exceeds the combined areas of New England, New York, Pennsylvania, New Jersey, Delaware, Maryland, Virginia, the District of Columbia and West Virginia—all west of the Mississippi. Already the policy is amply justified by its fruits. Now let it be extended.

For the establishment of a national forest to protect the grand old

white hills of New Hampshire and the great commercial and manufacturing interests dependent thereupon an argument may be made almost or quite as strong as that for the protection of the Southern Appalachian forests.

Nine years ago the struggle began for the establishment of national forests first in the southern Appalachians, and then in the White Mountains. In the fifty-ninth Congress this effort almost succeeded. The bill was unanimously passed by the Senate and reported without dissent for passage by the House Committee on Agriculture. The president approved it in advance and strongly urged its passage. Through the opposition, however, as is generally understood, of the speaker, this bill could not be brought to a vote in the House. The fifty-ninth Congress did, however, appropriate $25,000 for surveying the Appalachian-White Mountain area. In the summer following, the survey was made and the report was made at the first session of the sixtieth Congress. Appalachian bills were promptly introduced into both Houses. The House bills went to the Committee on Agriculture. Here, on January 30, a hearing was had. It lasted an entire day and was of a character apparently to convince all who were open to conviction. Later, however, the constitutional question was raised and the bill was sent to the House Committee on Judiciary. A hearing was had before this committee on February 27, the arguments for and against

A SERIOUS FIRE WAS STOPPED AT THIS LANE. It is 60 feet wide, and was hastily cut through a Dense Sapling Stand. Litter scraped up on the right.
Beede, Adirondack Mountains, N. Y.

LINVILLE RIVER AND FALLS, showing Steep Rocky Gorge, whose Walls are from 500 to nearly 2,000 feet high. Byums Bluff, Mitchell Co., N. C.

the constitutionality of the measure being presented. Then came the familiar delay. Meanwhile boards of trade, chambers of commerce, women's clubs, civic and patriotic organizations and individuals without number representing every section of the country, every political creed and practically every social class and interest, poured in letters, telegrams, petitions and resolutions, as one congressman declared, "by the millions." The Senate passed the bill.

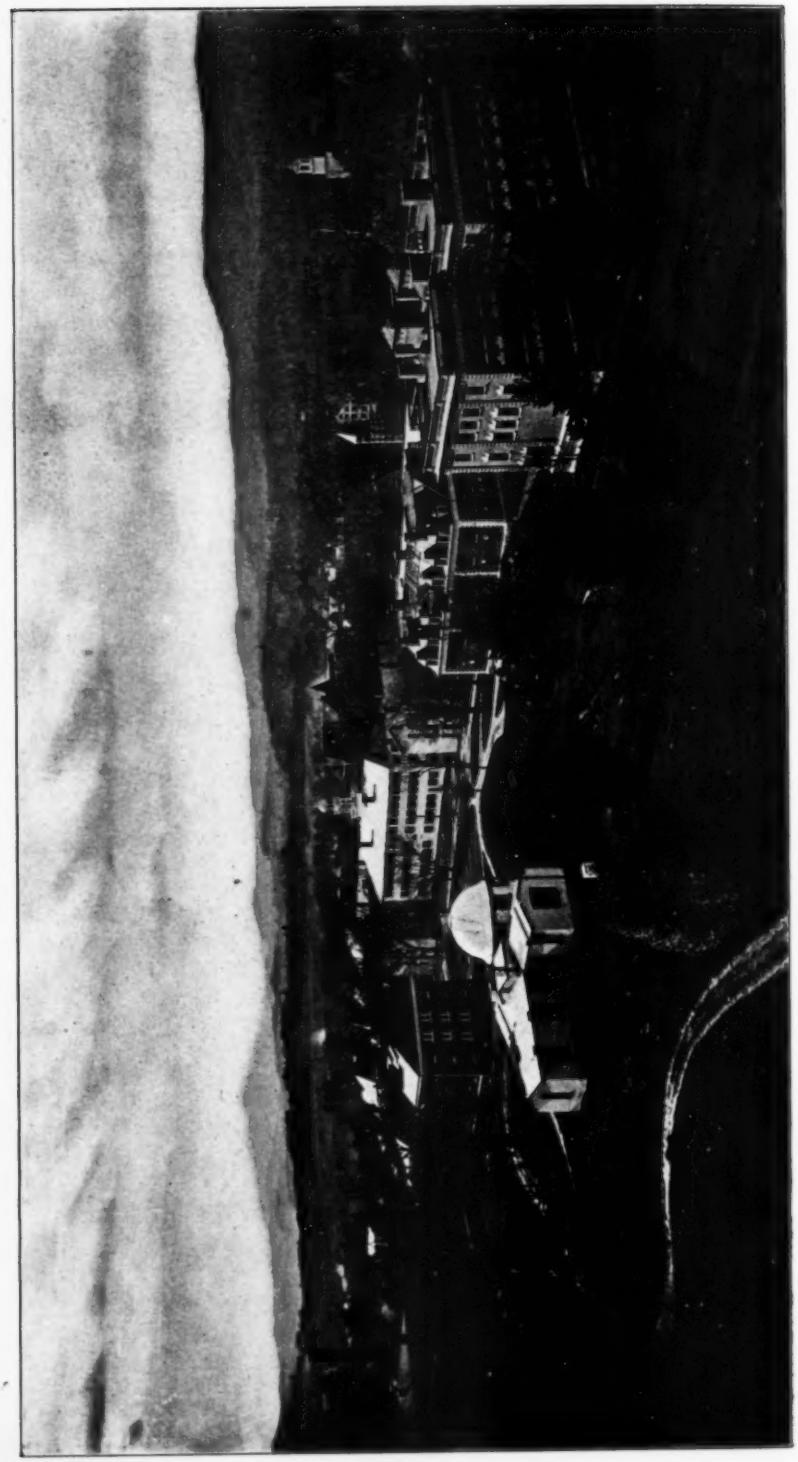
The House Committee on Judiciary, by unanimous vote, on April 22, decided as follows:

Resolved, that the Committee is of opinion that the federal government has no power to acquire lands within a state, solely for forest reserves; but under its constitutional power over navigation, the federal government may appropriate for the purchase of lands and forest reserves in a state, provided it is made clearly to appear that such lands and forest reserves have a direct and substantial connection with the conservation and improvement of the navigability of a river, actually navigable in whole or in part; and any appropriation made therefor is limited to that purpose.

Resolved, that the bills referred to in the resolutions of the House, H. R. 10,456 and H. R. 10,457, are not confined to such last mentioned purpose, and are therefore unconstitutional.

This decision, apparently adverse, was really favorable. The bills were at once modified to meet the requirements of the Judiciary Committee and reintroduced. The Agricultural Committee of the House, however, reported a new bill, providing only for a Congressional investigation or "junket" during the recess. This passed the House, but went no farther.

Effort should now be concentrated on the House, to secure the passage, by that body, of the excellent Senate bill. Already the tide of public opinion has risen high in favor of this legislation. It is still rising. An earnest, united, systematized effort, by all concerned, should bring success at the next session of Congress.



DARTMOUTH COLLEGE AND THE SURROUNDING COUNTRY

THE PROGRESS OF SCIENCE

DARTMOUTH COLLEGE AND THE SUMMER MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE American Association for the Advancement of Science in planning a special summer meeting had in view a visit to an educational institution of interest in a region attractive in the summer time, rather than a convenient place for the presentation of scientific papers. The meeting was entirely successful from the point of view of place and environment, and the fact that the scientific programs were not extensive was scarcely a drawback. Nor did the small attendance interfere seriously with the pleasure of those present, though it seems a pity that only two of the eleven sections of the association organized and that but few of those interested in sciences other than physics and geology made the meeting an occasion to visit Dartmouth College and meet their friends.

It is perhaps true that the holidays are not the best time to visit a college, which should be regarded as its men and their work rather than as its buildings and equipment. But in any case it is not possible for a visitor to do more in a couple of days than obtain a general impression. Dartmouth is one of the oldest of our colleges and one of those which have grown most rapidly in recent years. It is in many ways a typical New England college, though its school of medicine and its graduate schools of engineering and affairs give it better warrant to bear the name of university than many institutions which assume this dignity.

Dartmouth College traces its origin to a school for the christian education of young Indians, opened in 1754; it received a charter with its present name in 1769. In 1819 a lawsuit between the trustees and the state of New Hampshire was decided which made the college independent of the state. Otherwise it might have been the University of New Hampshire, and this it may yet become. The reaction against state control which separated most of the eastern institutions from the state is not apparent west of the Atlantic seaboard, and it is by no means unlikely that through their colleges of agriculture and the mechanic arts or by adoption of one of the privately controlled institutions there may yet be state universities in each of the eastern states.

The Dartmouth Medical School began with the appointment of a professor of medicine in 1798. The Thayer School of Engineering was established in 1867 and the Amos Tuck School of Administration and Finance in 1900. These two schools are based on the college course, or rather, following the "Columbia plan," on the first three years, the last year of college and the first year of the professional school being identical. The college predominates, having 1,102 of the 1,219 students in the institution. In it the group system obtains and the possibility of completing the course in three years. Latin is required for the bachelor of arts degree, but not Greek. The students in the course leading to the bachelor of science degree, for which neither Latin nor science is required, are about half as many.

The catalogue says that the undergraduate life develops independence,

DARTMOUTH HALL. Used for the opening exercises and public lectures

COLLEGE HALL. Headquarters of the association

originality, adaptability and broadness of mind, and probably uses with discretion "life" rather than "curriculum." The general spirit in the college is said to be excellent, and credit is given for this, as well as for the remarkable growth of the institution, to President Tucker.

As shown by the accompanying illustrations, the situation of Dartmouth among the New Hampshire hills is beautiful, and the campus and buildings make a pleasing impression. The original Dartmouth Hall, destroyed by fire, has been rebuilt effectively in brick. College Hall, a club house and commons, made excellent headquarters for the association. The scientific departments are well housed in the Butterfield Museum for the natural sciences, the Wilder Laboratory for physics, Culver Hall containing the chemical department and the Shattuck Observatory.

INTERNATIONAL CONGRESSES AND PERMANENT INTERNATIONAL BUREAUS

SCIENCE and commerce are breaking down the barriers between the nations. Commerce is at present competitive, having tariffs, navies and the rest as its adjuncts, but it will gradually become denationalized. Science is by its very nature cooperative, and international congresses advance in equal measure science and good will. Of somewhat unusual interest are the two international congresses which meet in Washington next month, one concerned with fisheries and one with tuberculosis. The fisheries are to a considerable extent subject to international control, and tuberculosis is the disease most likely to be mitigated by combined action against it.

The fisheries congress, which is the fourth to be held, opens on September 22, and after the sessions in Washington, special meetings will be held in New York, Boston, Gloucester and possibly in other places in New England. Other places which may be visited are Baltimore, the center of the oyster industry of Chesapeake Bay, and Chicago and other lake ports, where the fishery trade and methods of the great lakes, the most valuable fresh-water fisheries in the world, may be studied. Twelve governments have already accepted the invitation of the United States to be officially represented, and delegates have been appointed by the governors of many of the states. In view of the large number of persons who will attend as individuals or as representatives of important fishery societies, the congress promises to be important in its representative character, size and the value of its proceedings. The subjects included in the program are: Commercial fisheries; Matters affecting the fishermen and the fishing population; Legislation and regulation; International matters affecting the fisheries; Aquiculture; Acclimatization; Fishways; Biological investigation of the waters and their inhabitants; Diseases and parasites of fishes; Crustaceans, mollusks and other water animals; Angling and sport fishing.

The International Congress on Tuberculosis will meet on September 28, in the new building of the United States National Museum, where an extensive exhibit will be arranged. Six or seven hundred delegates from all nations of the world will be present, and the pathologists, physicians and students of social conditions will probably be numbered by the thousands. The members will include the most eminent students of the disease, and their discussions will lead to the diffusion of knowledge concerning causes and remedies and to renewed efforts to increase knowledge. The congress will also perform an important service by awakening popular interest and concern. More than 6,000,000 of those now living in the United States will die of tuberculosis, yet it is essentially a preventable disease. Both of the

political parties have pledged themselves to increase the national agencies for suppressing disease and promoting the public health, and public sentiment will doubtless be further awakened by this congress.

International scientific congresses are leading to permanent international bureaus. Thus an International Association for Cancer Research has been founded at Berlin, to promote the investigation of cancer and the care of cancer patients, the collection and publishing of international cancer statistics, and the establishment of an international center of information on all matters concerning cancer research. Other objects of the association are the publication of an international technical organ and the organization of international cancer conferences. So far, thirteen states, including all the great powers except Great Britain, have joined the association, the seat of which will be at Berlin.

The International Institute of Agriculture was formally opened on May 23 by the king of Italy, who has given it a building and an endowment yielding $60,000 a year. The new building in the gardens of the Villa Borghese in Rome is said to be admirably suited to the purposes of such an institution. All civilized nations have joined in this movement, inaugurated three years ago, and it promises much for the promotion of agriculture throughout the world.

Permanent international bureaus must have a local home, and in addition to the two new institutions noted here there are others in London, Paris and Berlin. There are none in this country, and it is but proper that we do our share. The fisheries and research in tuberculosis and propaganda for its suppression would be proper objects for our government to promote, and it may be hoped that the approaching congresses will lead to the establishment of international bureaus at Washington for one or both of these objects.

SCIENTIFIC ITEMS

We regret to record the deaths of Mr. Henry Lomb, one of the founders of the Bausch and Lomb Optical Company; of Dr. Chamberland, subdirector of the Pasteur Institute; of Dr. Ostwald Seeliger, professor of zoology at Rostock, and of Dr. Rudolf Credner, professor of geography at Greifswald.

The Albert medal of the Royal Society of Arts has been awarded to Sir James Dewar.—Sir William Ramsay succeeds Lord Kelvin as a member of the Dutch Academy at Amsterdam.—Colonel W. C. Gorgas, eminent for his work on yellow fever, chief sanitary officer of the Isthmian Canal Zone, has been elected president of the American Medical Association.

Mr. Henry Phipps, of Pittsburg and New York, has made a large gift to the Johns Hopkins University for the founding of a Psychiatric Clinic. It provides for the construction of a hospital building, together with apparatus, and laboratories for the scientific investigation of mental abnormalities by pathological, chemical and psychological methods. Mr. Phipps will provide for the maintenance of a medical and nursing staff, including salaries for a professor of psychiatry and assistants and other expenses for a period of ten years. The total amount of the gift is withheld in accordance with the wishes of Mr. Phipps, but it is understood that it will considerably exceed half a million dollars. Dr. Adolf Meyer, director of the Pathological Institute of the New York State Hospitals, has accepted the professorship of psychiatry and the directorship of the hospital and clinic.